ENERGY INDICATORS

Contents

Introduction

Energy is a critical component of every aspect of Washington's economy and is used daily by every resident of the state to meet the most basic human needs. Energy lights and heats our homes, cooks our food, fuels our vehicles, and powers our industries. This document portrays some key trends taking place throughout Washington State in this crucial industry. This series of 24 "Energy Indicators" illustrates some of the most important long-term energy trends. Each indicator consists of a chart based on readily available energy, economic, and demographic information, a caption highlighting key trends depicted in the chart, and narrative giving additional perspective or describing further aspects of the indicator.

This is the most current version of the Energy Indicators, which were first published in 1999 as part of the 1999 Biennial Energy Report. The Indicators began as a successor to the Washington State Energy Use Profile, which was published periodically in the past by the Washington State Energy Office, most recently in June of 1996.

In order to ensure that the Energy Indicators presented here are grounded in the best available information and can be updated on a regular basis, they are based as much as possible on regularly published data from sources in the public domain. The U.S. Energy Information Administration (EIA) has the most complete sources of annual, state-level energy data (www.eia.doe.gov). Our principal source is the EIA's Combined State Energy Data System (SEDS), the database used to publish the State Energy Data Report (SEDR) and the State Energy Price and Expenditure Report (SEPER). Some other sources include the US Bureau of Economic Analysis (US BEA), the US Census Bureau, the President's Council of Economic Advisors (CEA), the Washington State Office of Financial Management (WA OFM), US Department of Energy Center for Transportation Analysis (USDOE) and the Washington State Fuel Mix Database. The sources for each indicator are listed at the end of this document.

Collecting and publishing detailed statistics on energy consumption, price, and expenditures for fifty states and the District of Columbia is a large task involving analysis and compilation of fuel- and sector-specific data. Thus comprehensive state information from EIA lags by two to three years. Consequently, the Energy Indicators are confined to analysis of long-term energy trends.

However, we have developed some indicators of more recent energy trends using different energy data sources. This information can be found in Section 4 of Washington's Energy Strategy Update and 2003 Biennial Energy Report (http://www.energy.cted.wa.gov/Energy%20Strategy/Default.htm). Note that this more current information is often based on preliminary data that is developed from small samples. This information is subject to change. In addition, changes in energy markets have made it more difficult to accurately collect some current energy data and in some cases have restricted access to this information. Combined with limited government resources for organizations like EIA, the availability of comprehensive energy data is declining.

Contact Information

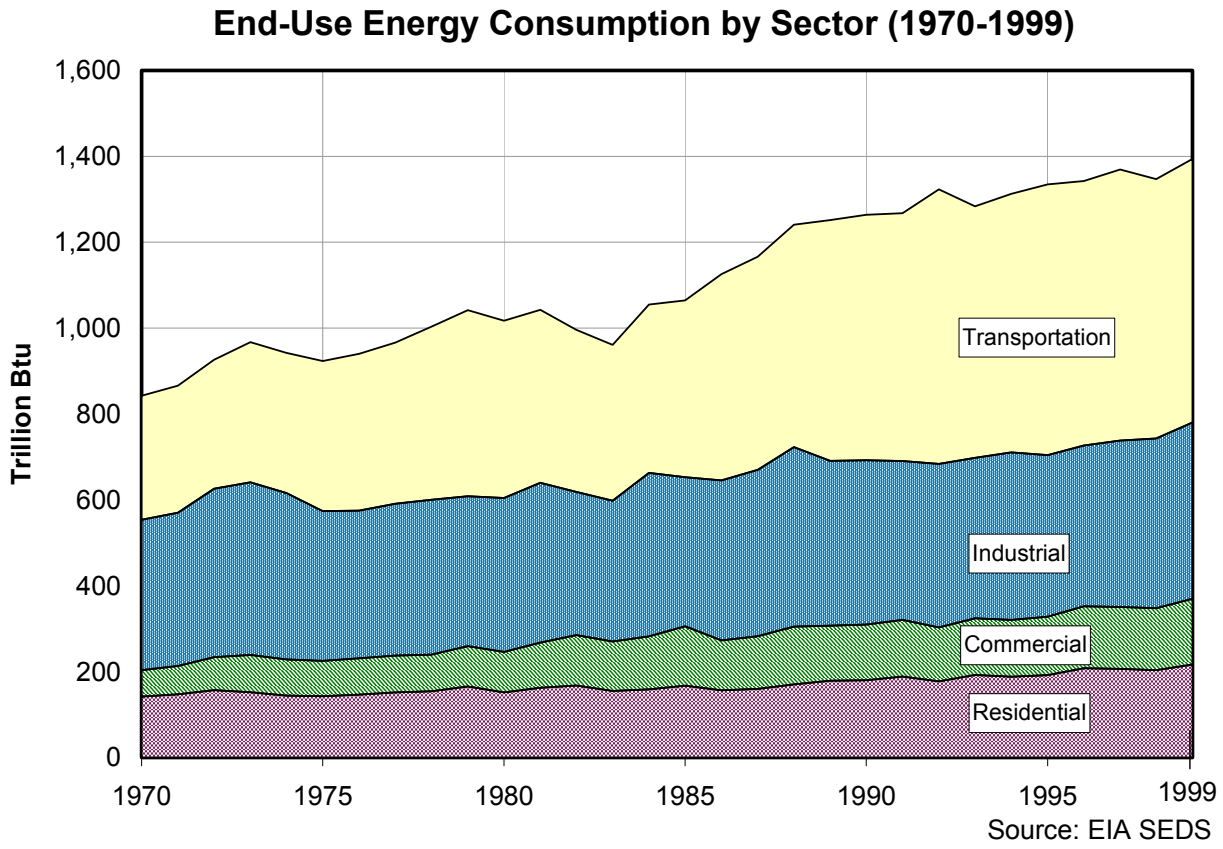
Washington State Department of Community, Trade & Economic Development, Energy Policy Division

Greg Nothstein (360) 956-2098 Gregn@ep.cted.wa.gov

Stacey Waterman-Hoey (360) 956-2168 WatermanS@energy.wsu.edu

URL: www.energy.cted.wa.gov

1. Washington's Energy Use — End-Use Energy Consumption



END USE ENERGY CONSUMPTION IN WASHINGTON WAS TWO-THIRDS HIGHER IN 1999 THAN IN 1970. MOST OF THE INCREASE OCCURRED IN THE TRANSPORTATION SECTOR, WHERE ENERGY USE HAS MORE THAN DOUBLED SINCE 1970. TRANSPORTATION NOW ACCOUNTS FOR MORE THAN 40% OF THE STATE'S ENERGY CONSUMPTION.

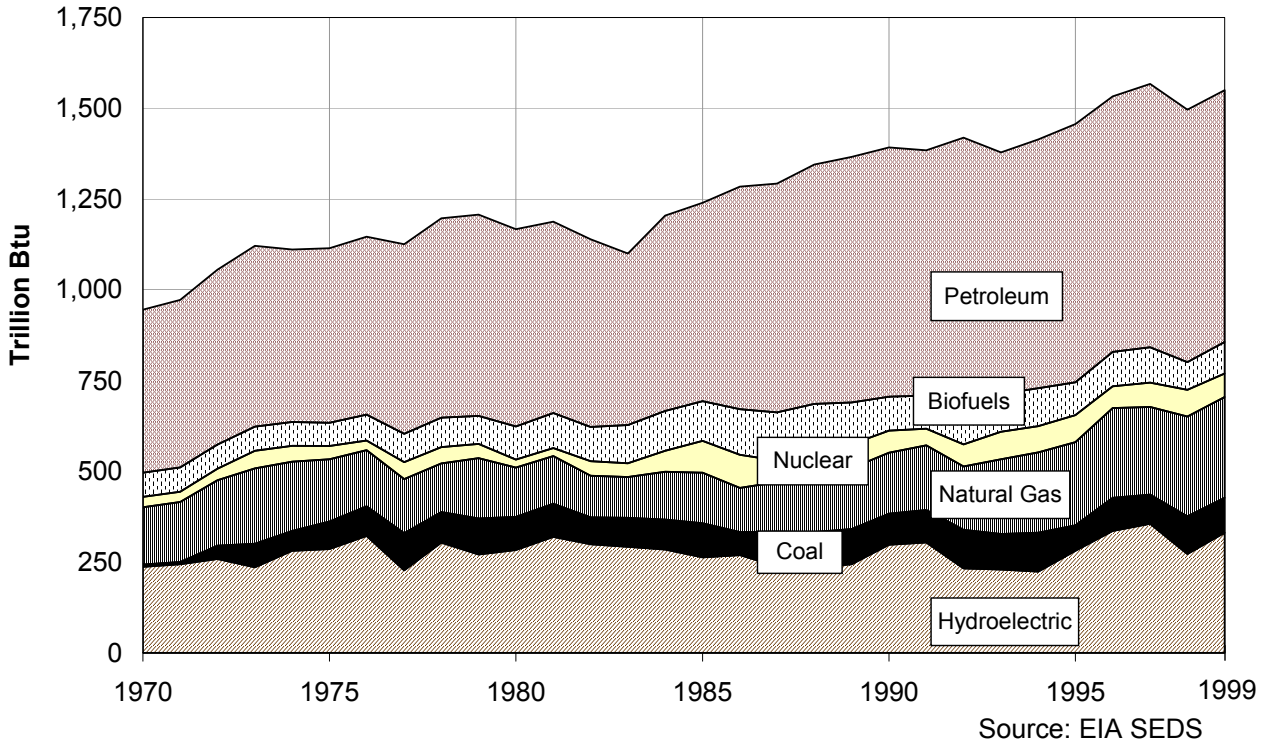
Washington's end-use energy consumption grew at 1.9% per year between 1985 and 1999, reaching an all-time high of 1.4 quadrillion Btu in 1999. The transportation sector accounts for the largest share of growth in energy consumption, growing at an annual rate of 2.9% since 1985.

During the 1970s and early 1980s, growth in energy consumption was dampened by higher energy prices and changes in the state's economy. Industrial sector energy consumption was nearly flat between 1970 and 1985. Energy consumption in the commercial sector, which includes service industries such as software, finances, and insurance, more than doubled over the same period, but remains small relative to other sectors.

The period since 1985 has been characterized by modest growth in the commercial, industrial, and residential sectors, where energy consumption grew at 0.8%, 1.2%, and 1.9% per year respectively between 1985 and 1999. Growth in the transportation sector was 2.9% during this period.

2. Washington's Energy Use — Primary Energy Consumption

Total Primary Energy Consumption by Source (1970-1999)



Source: EIA SEDS

WASHINGTON CONTINUES TO RELY ON PETROLEUM FUELS FOR ABOUT HALF OF ITS PRIMARY ENERGY USE. THE RELATIVE CONTRIBUTION OF HYDROELECTRICITY AS AN ENERGY SOURCE HAS DECLINED.

This indicator shows the extent of Washington's reliance on six major primary energy sources: petroleum, hydroelectricity, natural gas, biofuels, coal, and uranium. Washington continues to rely on petroleum, more than three-quarters of which is imported by tanker from Alaska, to meet 45% of its primary energy needs. This share of primary energy use has not changed appreciably since 1970. Fossil fuels (petroleum, coal, and natural gas) accounted for 69% of primary energy use in 1999.

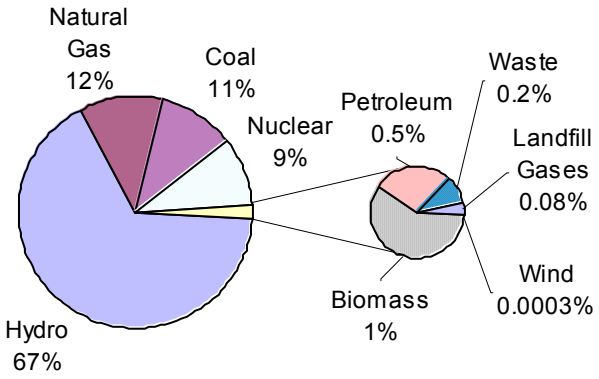
Hydroelectricity's relative importance has declined since the early 1980s. While total generation from hydroelectric dams has stayed relatively constant, consumption of natural gas has grown rapidly. Natural gas consumption has more than doubled since 1983, regaining the market share it lost during the 1970s. Natural gas now accounts for nearly 18% of Washington's primary energy consumption.

Biofuels, mainly wood and wood waste products, account for 6% of primary energy consumption. These fuels are primarily burned for steam and cogeneration at pulp and paper mills. Coal is consumed almost exclusively at the Centralia Steam Plant, while uranium is used at the Energy Northwest's Columbia Generating Station plant in Richland. Together, coal and nuclear generation accounted for 10% of Washington's primary energy supply in 1999.

3. Washington's Energy Use — Electricity Generation and Consumption by Source

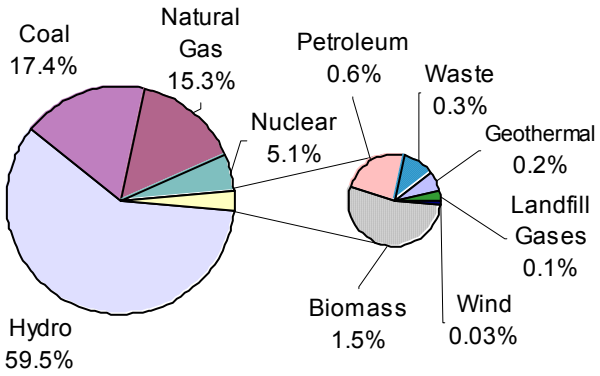
2001 Washington State Gross Generation by Fuel

Total = 87,166,471 MWhs



2001 Washington State Net Consumption by Fuel

Total = 78,210,687 MWhs



Source: Fuel Mix Disclosure Database

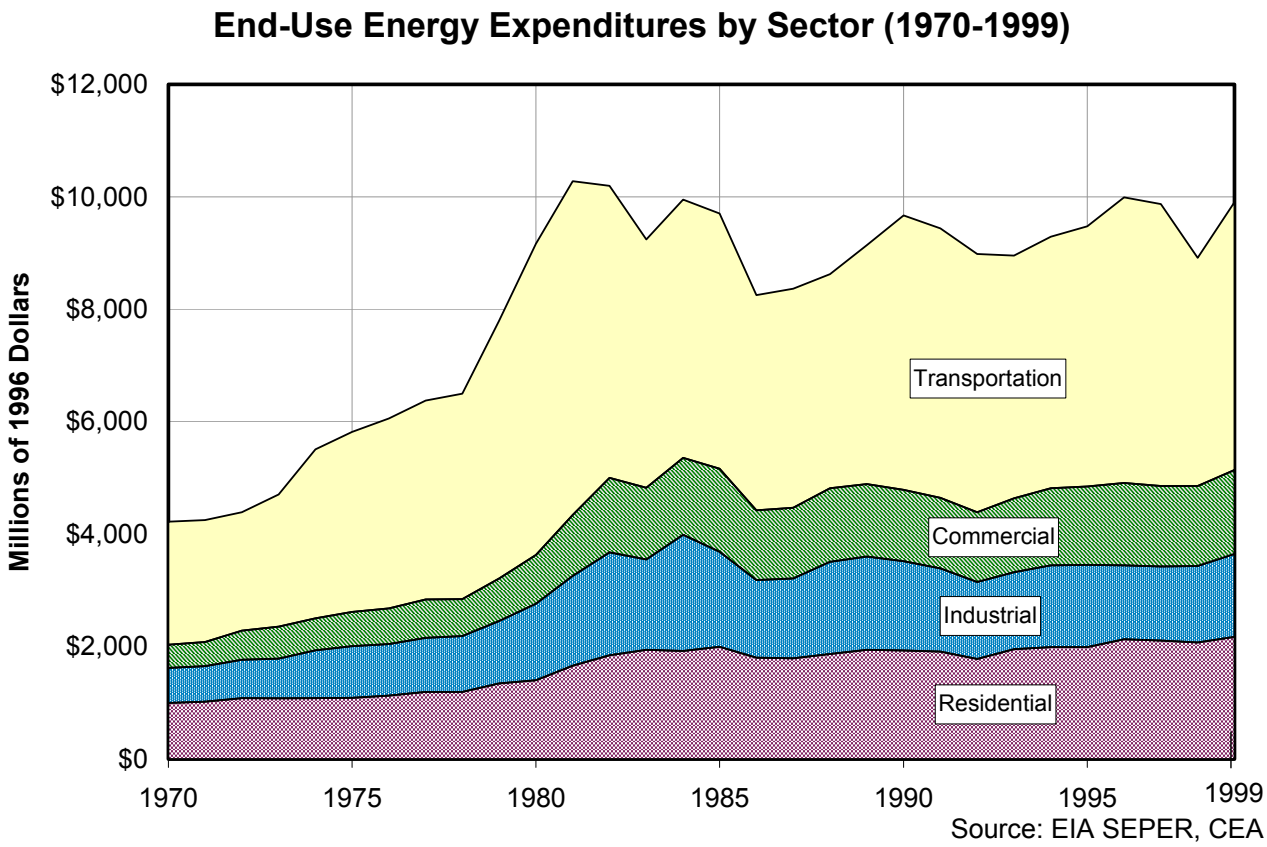
WHILE 67% OF THE ELECTRICITY GENERATED IN WASHINGTON IN 2001 (A VERY LOW WATER YEAR) CAME FROM HYDROELECTRIC DAMS, WASHINGTON CONSUMERS ARE SERVED BY ELECTRICITY FROM GENERATION PLANTS LOCATED THROUGHOUT THE WESTERN ELECTRICITY SYSTEM THAT USE A VARIETY OF ENERGY SOURCES

HOW MUCH OF WASHINGTON'S ELECTRICITY IS HYDRO? THE ANSWER DEPENDS ON HOW ONE DEFINES "WASHINGTON'S ELECTRICITY". WHILE HYDROELECTRIC DAMS ACCOUNTED FOR 67% OF THE ELECTRICITY GENERATED IN WASHINGTON IN 2001, WASHINGTON IS PART OF AN INTERCONNECTED, REGIONAL BULK POWER SYSTEM AND WASHINGTON CONSUMERS ARE DEPENDENT ON COAL, NATURAL GAS, AND NUCLEAR PLANTS IN OTHER STATES. MOREOVER, MUCH OF THE HYDROELECTRIC GENERATION IN WASHINGTON IS OWNED BY THE FEDERAL GOVERNMENT AND OPERATED ON BEHALF OF CUSTOMERS IN MULTIPLE STATES.

A better estimation for "Washington's electricity" is the mix of generation purchased by utilities to serve customers in Washington State. This data, collected for the Washington State Fuel Mix Disclosure Project, includes utility spot market purchases. Hydroelectricity is still the dominant source, but at 60 percent of the electricity consumed in the state, it is a little less than the generation share. Because 2001 was an extraordinarily low water year there was an increase in generation from non-hydro resources, primarily coal and natural gas.

Note that a significant portion of the natural gas fired generation in Washington is from cogeneration plants. These applications use both the electricity and heat energy from the power plant. Thus the overall energy efficiency of these plants is higher than an electricity generator alone.

4. Washington's Energy Bill — End Use Energy Expenditures

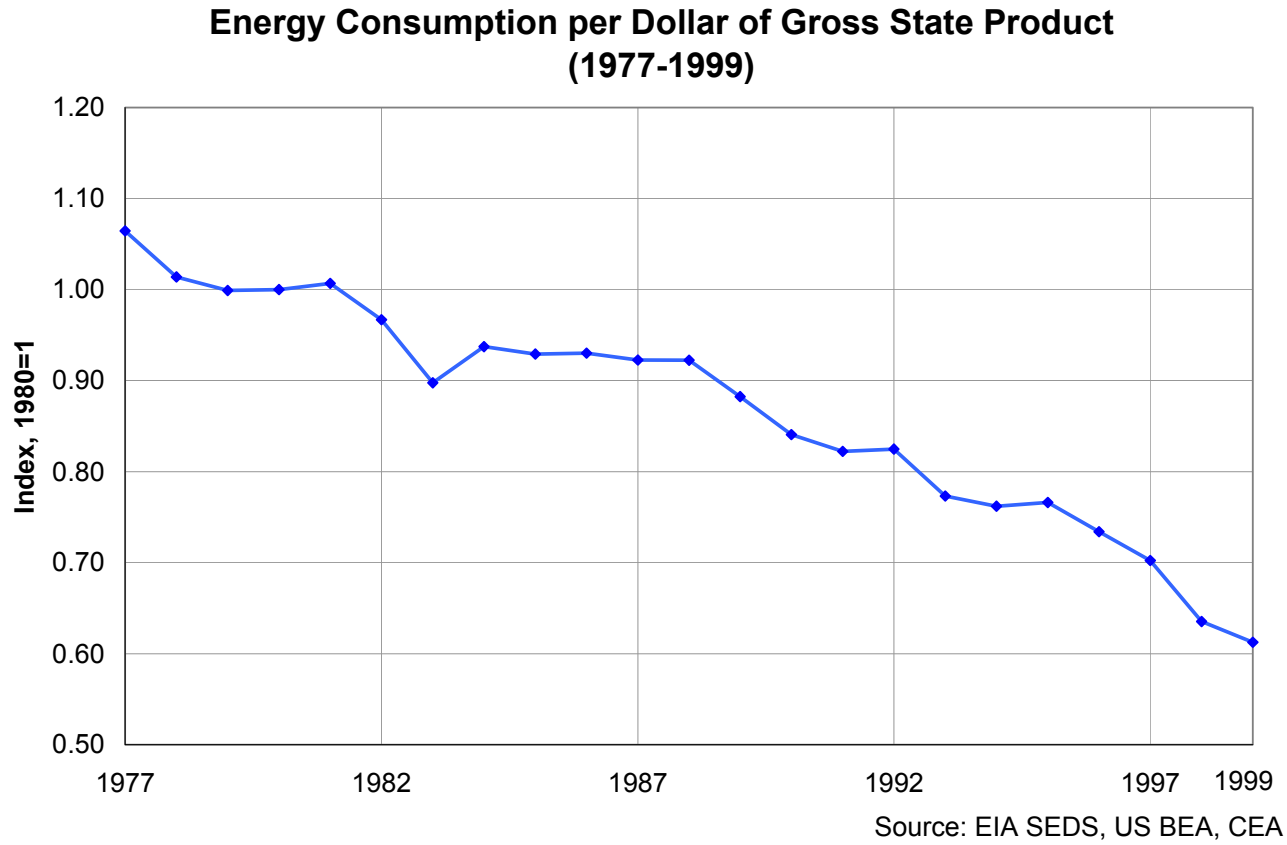


ADJUSTED FOR INFLATION, ENERGY EXPENDITURES IN WASHINGTON IN 1999 WERE A LITTLE LESS THAN THE PEAK EXENDITURES IN 1981, DESPITE A 34% INCREASE IN ENERGY CONSUMPTION DURING THAT PERIOD.

Washingtonians spent $10.3 billion on energy in 1999. While that represents more than a 90% increase over 1980 in nominal terms, when adjusted for inflation the amounts are similar, despite a 37% increase in energy consumption. Energy prices have not kept pace with inflation since oil and gas prices peaked in the early 1980s. This period contrasts sharply to the 1970s, when expenditures on energy increased by more than 100% in real terms.

The transportation sector accounts for the largest share of energy expenditures, 48% in 1999. This proportion declined, however, from over 60% in 1980, even as transportation's share of statewide energy consumption increased. The real price of petroleum fuels declined significantly since the early 1980's, while the price of electricity, an important energy source in the non-transportation sectors, stayed relatively constant.

5. Washington's Energy Intensity — Energy Consumption per Dollar of Gross State Product



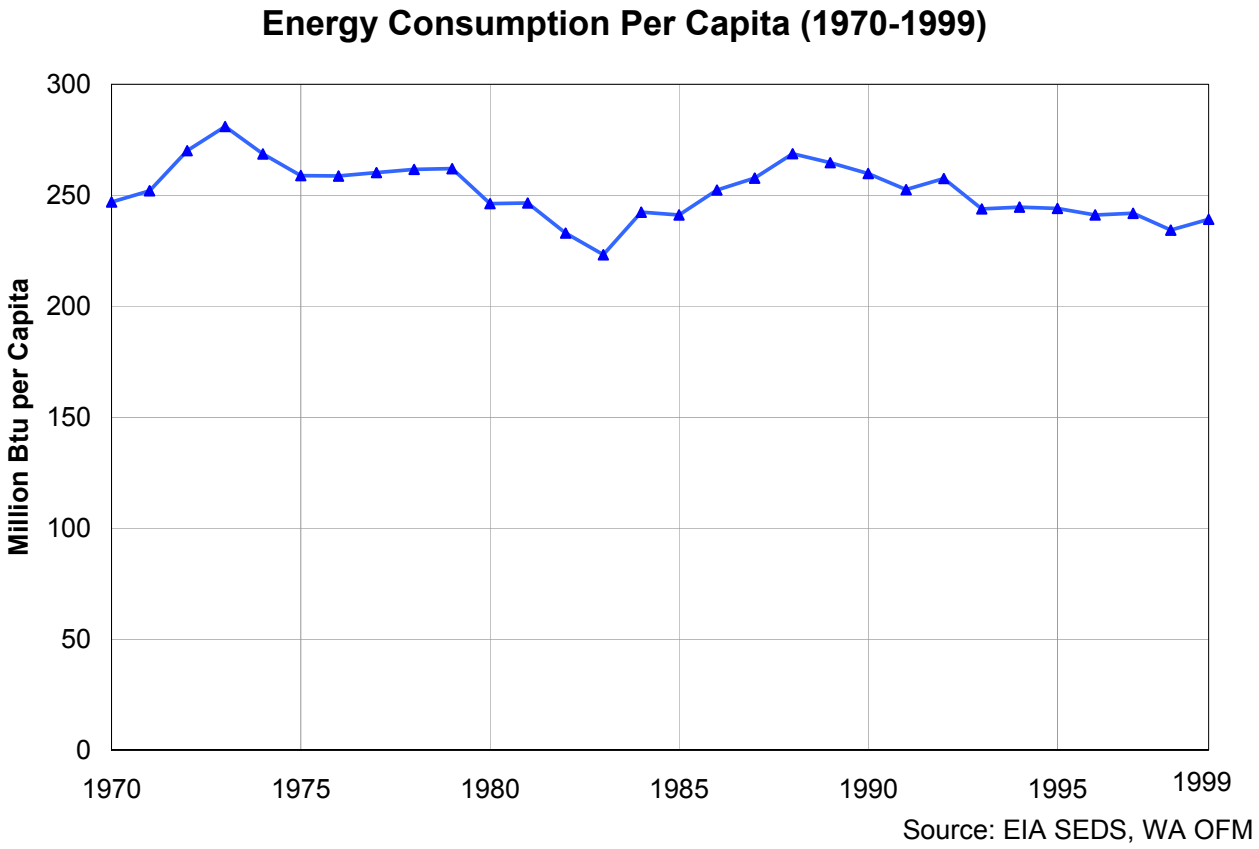
Source: EIA SEDS, US BEA, CEA

WASHINGTON CONTINUES TO PRODUCE MORE REAL VALUE IN GOODS AND SERVICES PER UNIT OF ENERGY CONSUMED, DESPITE GROWTH IN TOTAL ENERGY CONSUMPTION. KEY REASONS ARE A SHIFT IN THE STATE'S ECONOMY TO HIGH-VALUE BUSINESSES THAT ARE LESS ENERGY-INTENSIVE AND IMPROVED PROCESS EFFICIENCY.

This measure of the overall energy intensity of Washington's economy depicts the amount of energy we use to produce a dollar's worth of economic output. Washington energy consumption is divided by real Gross State Product (GSP, the sum of all goods and services produced in the state in constant dollars) and the result is indexed so that the value in 1980 is equal to one. Despite the rapid increase in Washington's total energy consumption between 1980 and 1999, energy consumption per dollar of GSP declined by 39% over the period.

Washington's economy is growing faster than its energy consumption, and has been since at least 1977, when the Gross State Product data series we use begins. This is due to a number of factors, chief among them is growth in the state's economy and a shift from resource and manufacturing industries to commercial activity based on software, biotech, and other less energy intensive businesses. Gains in process energy efficiency have also contributed.

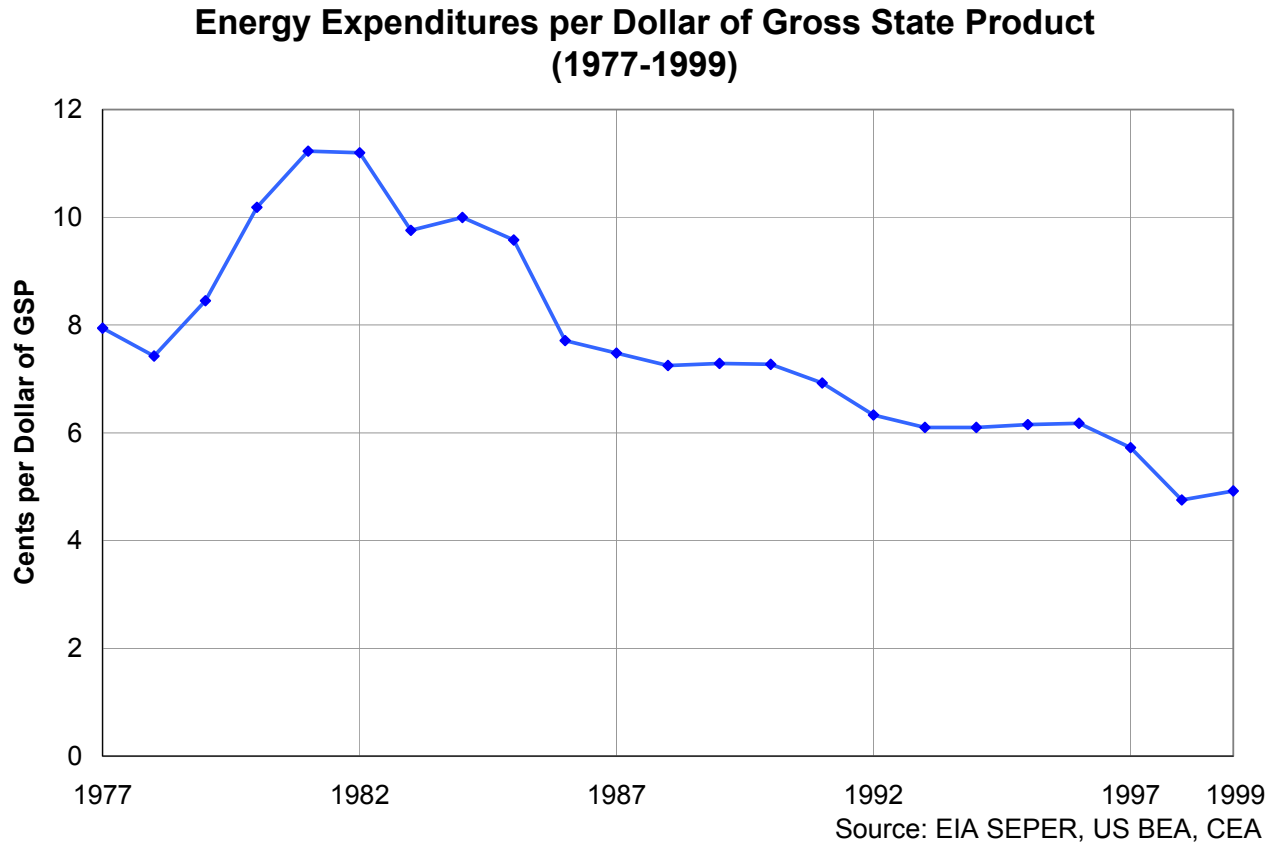
6. Washington's Energy Intensity — Energy Consumption per Capita



ENERGY CONSUMPTION PER CAPITA IS SIMILAR TODAY TO LEVELS IN 1970. EXCEPT AT THE DEPTHS OF THE EARLY-1980S RECESSION, ENERGY CONSUMPTION PER CAPITA IN WASHINGTON HAS STAYED RELATIVELY CONSTANT.

Another way to look at Washington's energy intensity is energy consumption per capita. While the previous indicator demonstrated that Washington continues to create more wealth per unit of energy, here the story is somewhat different. Washington's per capita energy consumption in 1999 was 242 million Btu. That's the energy equivalent of about 2000 gallons of gasoline per person, and is similar to the figure for 1970. Energy consumption per capita declined 20% between 1973 and 1983, to a low of 223 million Btu per person in 1983. This was followed by a period of growth in per capita energy use. Most of the increase occurred in transportation fuels, as communities began to sprawl and Washingtonians drove more and more miles per year. Per capita energy consumption was relatively flat through the 1990s as growth in energy consumption matched increases in population.

7. Washington's Energy Intensity — Energy Expenditures and Gross State Product

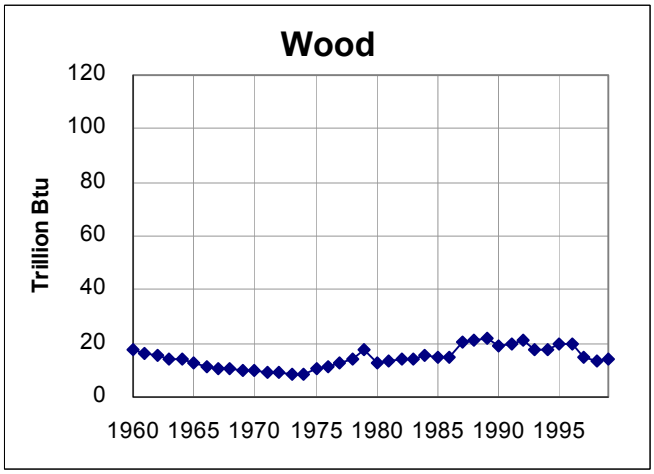


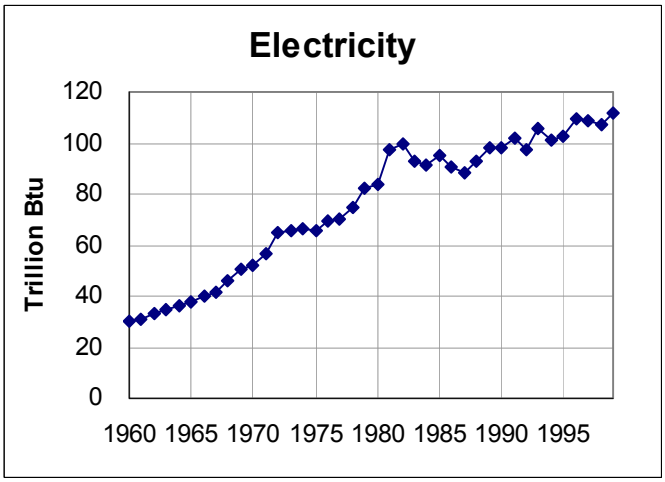
ENERGY EXPENDITURES ARE DECLINING RELATIVE TO ECONOMIC OUTPUT, DESPITE GROWTH IN ENERGY CONSUMPTION. PRINCIPAL CAUSES ARE DECLINING ENERGY INTENSITY AND LOWER ENERGY PRICES.

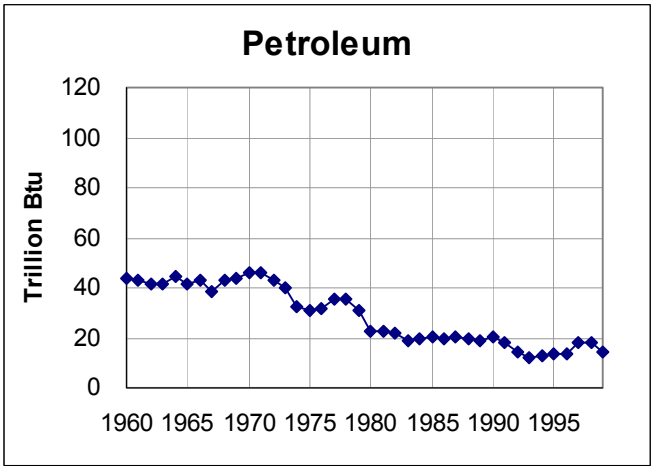
This indicator divides statewide energy expenditures by economic output, in the form of Gross State Product. The result is an estimate of the significance of energy in Washington's economy. Approximately 4.9¢ is spent on energy in Washington for every dollar of gross state product. This number has been declining steadily since peaking at slightly more than 11¢ in 1981. Two trends have contributed to this decline: Washington's economy is becoming less energy-intensive and real energy prices have declined. In 1998, energy expenditures were smaller relative to Washington's economy than at any time in history.

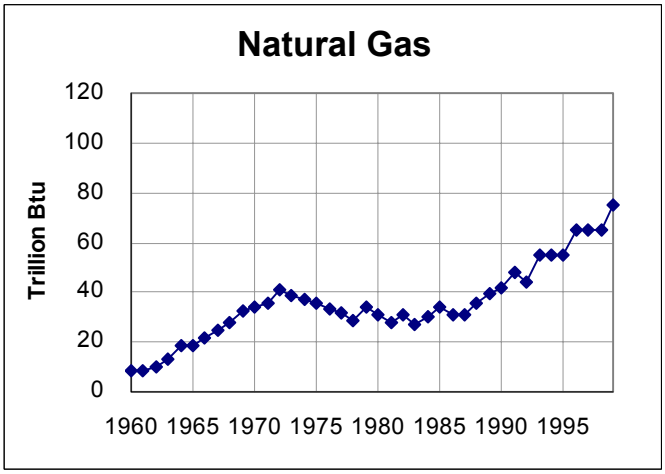
8. Residential Sector Trends — End-Use Energy Consumption by Fuel

Residential Energy Consumption by Fuel (1960-1999)









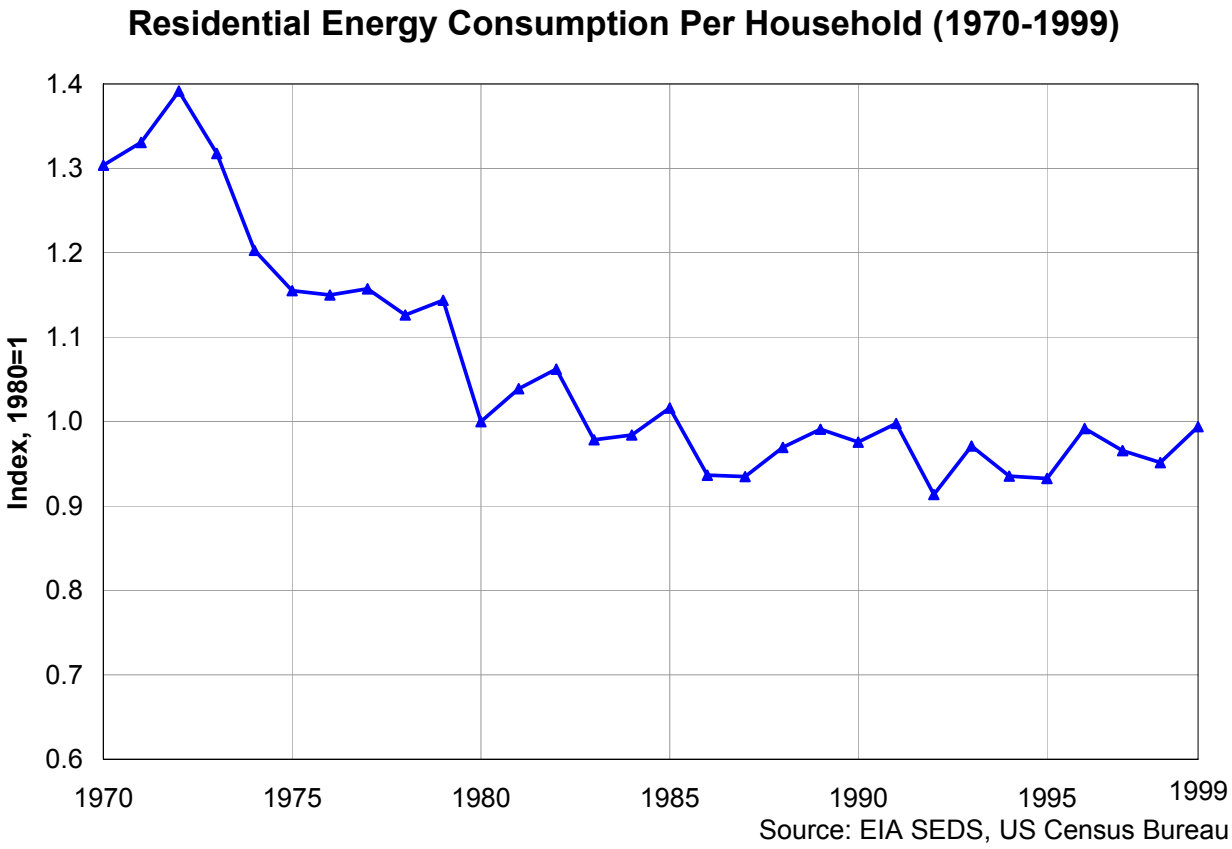
SOURCE: EIA SEDS

GROWTH IN HOUSEHOLD ELECTRICITY CONSUMPTION HAS SLOWED IN THE LAST 16 YEARS, WHILE GROWTH IN NATURAL GAS USE HAS ACCELERATED. OIL CONSUMPTION HAS DECLINED SIGNIFICANTLY SINCE THE EARLY 1970S, WHILE WOOD USE GREW A MODEST AMOUNT DURING THIS PERIOD BEFORE A SLIGHT DECLINE IN THE LAST SEVERAL YEARS.

Electricity accounts for a little more than half of residential energy consumption, but average electricity use per household has declined since 1982. Growth in natural gas consumption has accelerated: residential sector gas use grew at 1.9% per year between 1980 and 1985, 3.9% per year between 1985 and 1990, and 6.8% per year between 1990 and 1999. Petroleum use (mostly heating oil) fell from more than 43% of household consumption in 1960 to less than 7% in 1999.

Consumption of firewood grew in the late 1970s in response to high heating oil prices. After remaining relatively stable from the mid-1980s to mid-1990s, wood use declined a modest amount in the last several years.

9. Residential Sector Trends — Household Energy Intensity

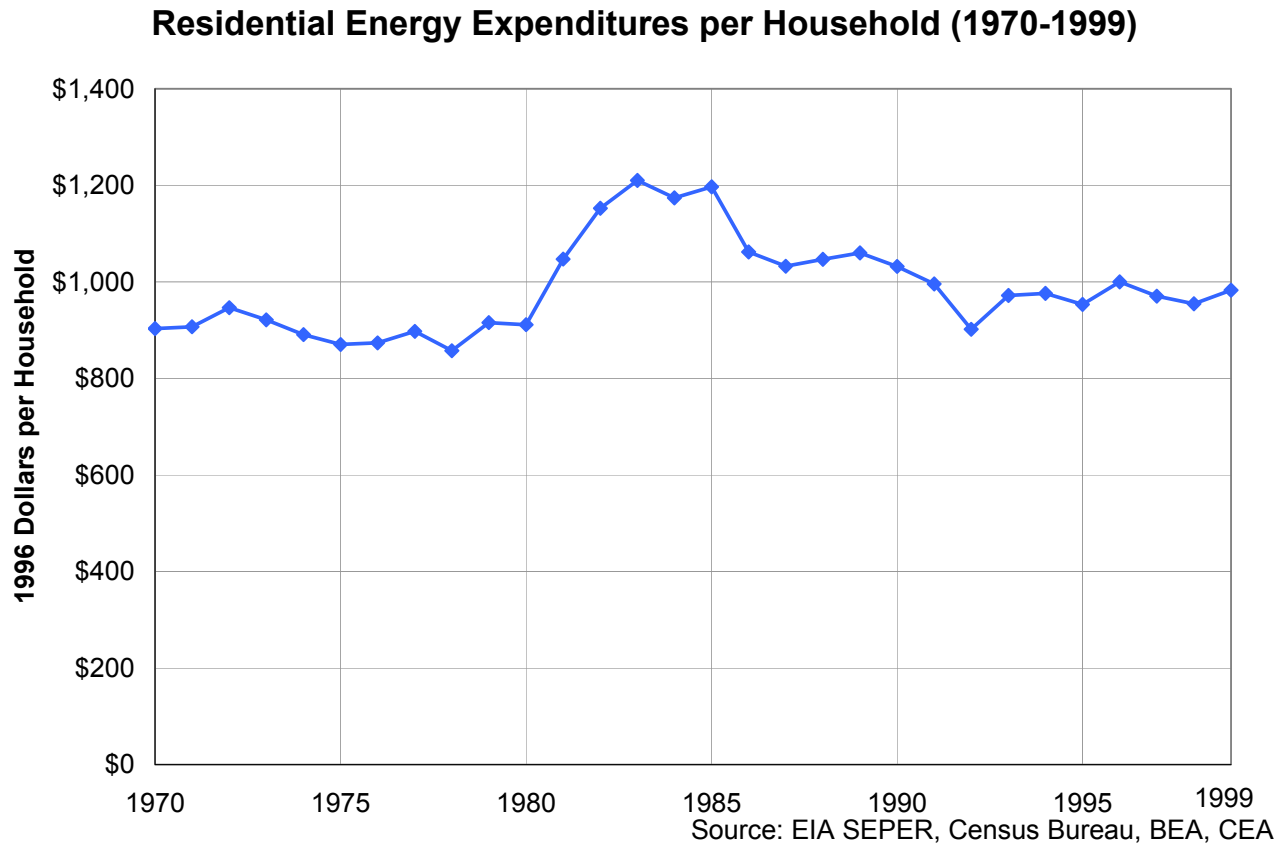


ENERGY CONSUMPTION PER WASHINGTON HOUSEHOLD DECLINED BY A THIRD BETWEEN 1972 AND 1987, INDICATING AN IMPROVEMENT IN HOUSEHOLD ENERGY EFFICIENCY. THERE HAS BEEN NO GAIN SINCE. CONSUMPTION PER HOUSEHOLD IN 1999 WAS SIMILAR TO 1985.

Washington households became much more energy efficient between 1972 and 1987, but there has been no improvement in efficiency since. The 1970s were characterized by diminished oil and natural gas consumption, with natural gas use per household falling by 33% between 1970 and 1980. Oil consumption dropped from 300 gallons per household in 1970 to 85 in 1983, with half the decline occurring after the second oil shock in 1978. The data indicate an increased reliance on wood and electricity as space heating fuels during the late 1970s and early 1980s.

Concerted efforts to improve residential efficiency through building standards and codes began in earnest in the mid-80s. However, there is little evidence of further declines in household energy use during this period. Presumably gains in efficiency due to building standards and codes are being offset by larger homes, more widespread use of air conditioning, and the significant proliferation of electricity-using appliances. Note that these data do not include energy used for personal transportation, which has increased markedly during the last fifteen years.

10. Residential Sector Trends — Household Energy Bill



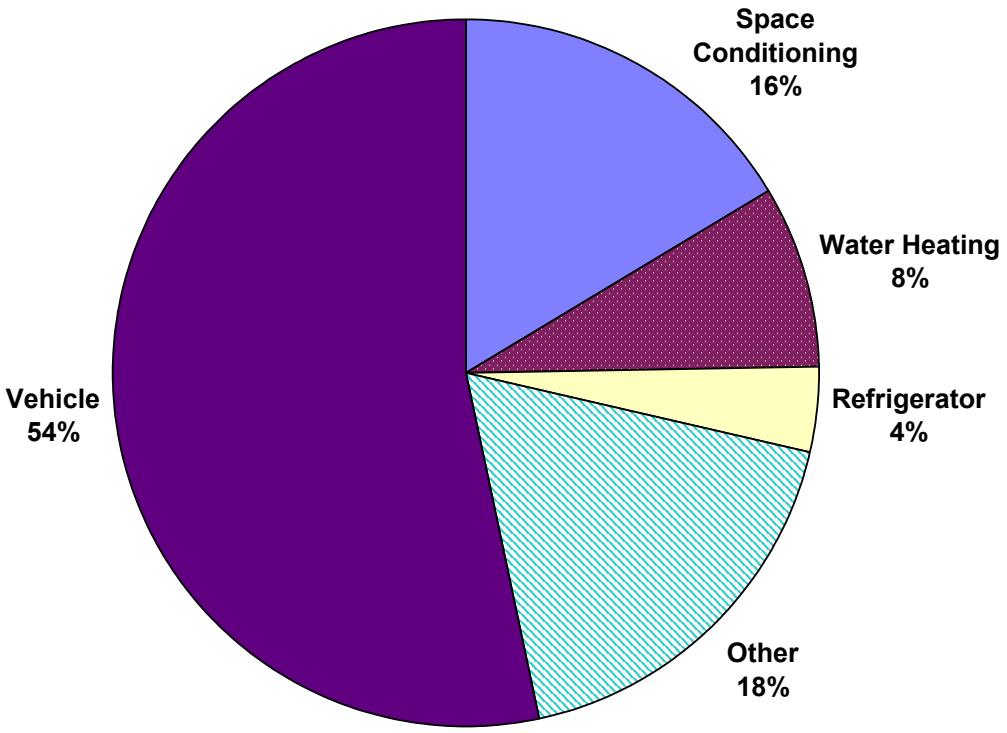
ADJUSTED FOR INFLATION, THE AVERAGE WASHINGTON HOUSEHOLD SPENT 9% MORE FOR HOME ENERGY IN 1999 THAN IN 1970. IMPROVEMENTS IN HOUSEHOLD ENERGY EFFICIENCY AND FUEL SWITCHING TO LESS EXPENSIVE ENERGY SOURCES HAVE OFFSET HIGHER ELECTRICITY PRICES.

In 1999, the average Washington household spent the inflation-adjusted sum of $983 (1996 dollars) for electricity, natural gas, and petroleum delivered to the home, roughly $80 more than in 1970. This outward similarity masks significant changes in the composition of household energy expenditures over the last 25 years. Increased emphasis on energy conservation and fuel switching from heating oil to wood helped to mitigate the impact of the oil shocks of the 1970s on the home energy bill of Washington households. However, there is no immediate substitute for electricity, so when electricity prices increased by 62% between 1980 and 1983, due largely to the inclusion in rates of the WPPSS nuclear bonds, the average household electricity bill increased by a like amount.

Over time, energy efficiency and fuel switching have helped reduce reliance on relatively expensive electricity. Most new homes are being built with natural gas heat and water heating (78% in 1998) and numerous existing households have switched to natural gas as well. Electricity usage per household fell 11% between 1985 and 1999 while natural gas usage increased 66%. Switching to a less expensive fuel produces significant cost savings.

11. Residential Sector Trends — Household Energy Bill with Transportation

Household Energy Bill by End Use 1999 ($2,200)



Source: EIA RECS, USDOT

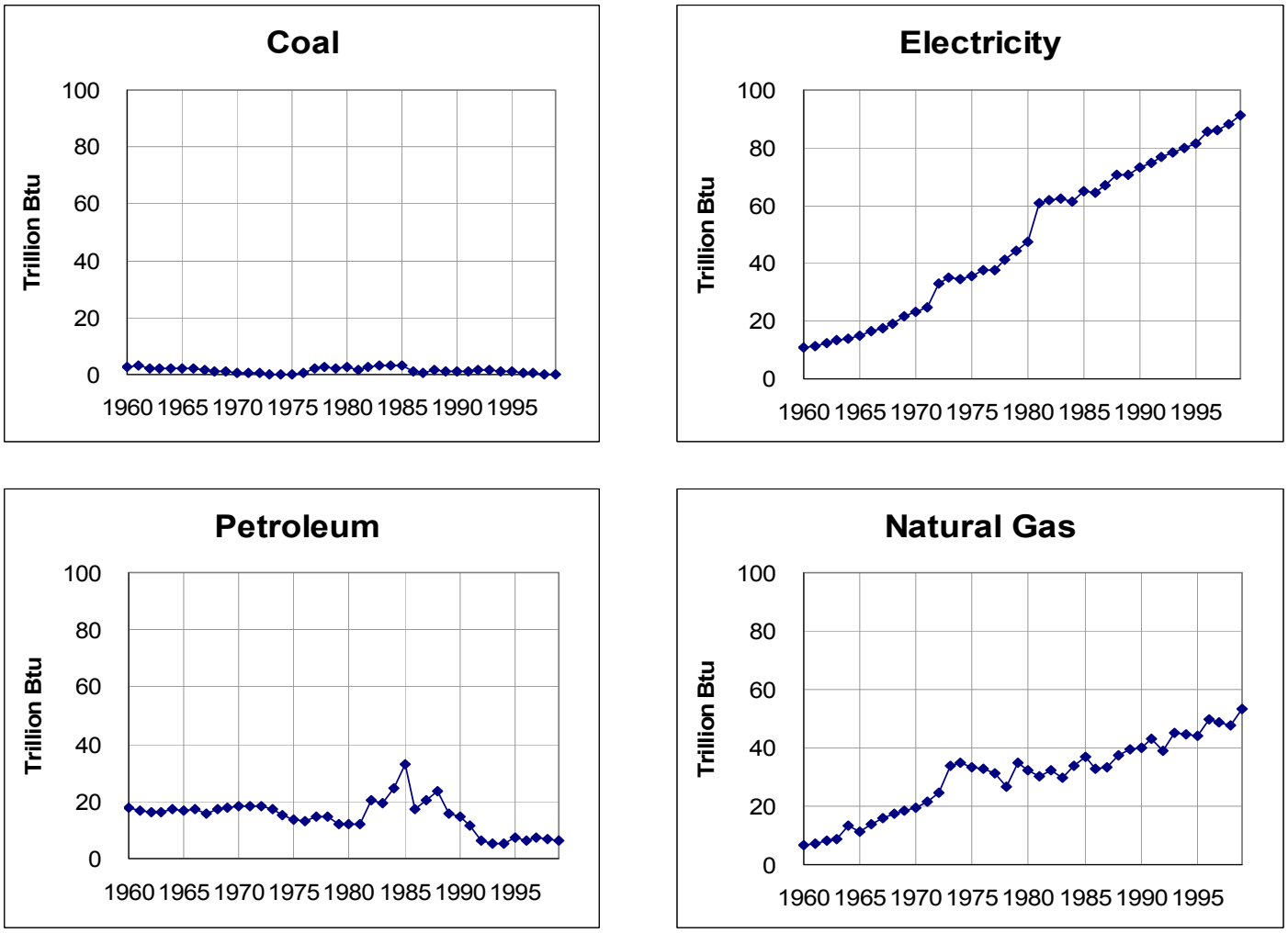
BY INCLUDING ENERGY USED FOR PERSONAL TRANSPORTATION, THE ANNUAL ENERGY BILL FOR THE AVERAGE WASHINGTON HOME MORE THAN DOUBLES.

Most views depicting residential energy data do not include the major component of consumption and expenditure at most homes – household vehicles. The average household in Washington spent over half of its energy budget fueling vehicles for transportation in 1999. This share will likely continue to be significant. While homes have become more energy efficient, people are likely to maintain or increase current levels of driving and they are using less fuel-efficient vehicles (see Indicators #17 and #18).

After personal transportation, major categories of household energy expenditures include space conditioning (heating, cooling, and ventilation), water heating, refrigerators, and other uses such as lighting, household appliances, and electronic equipment.

12. Commercial Sector Trends — End-Use Energy Consumption by Fuel

Commercial Energy Consumption by Fuel (1960-1999)



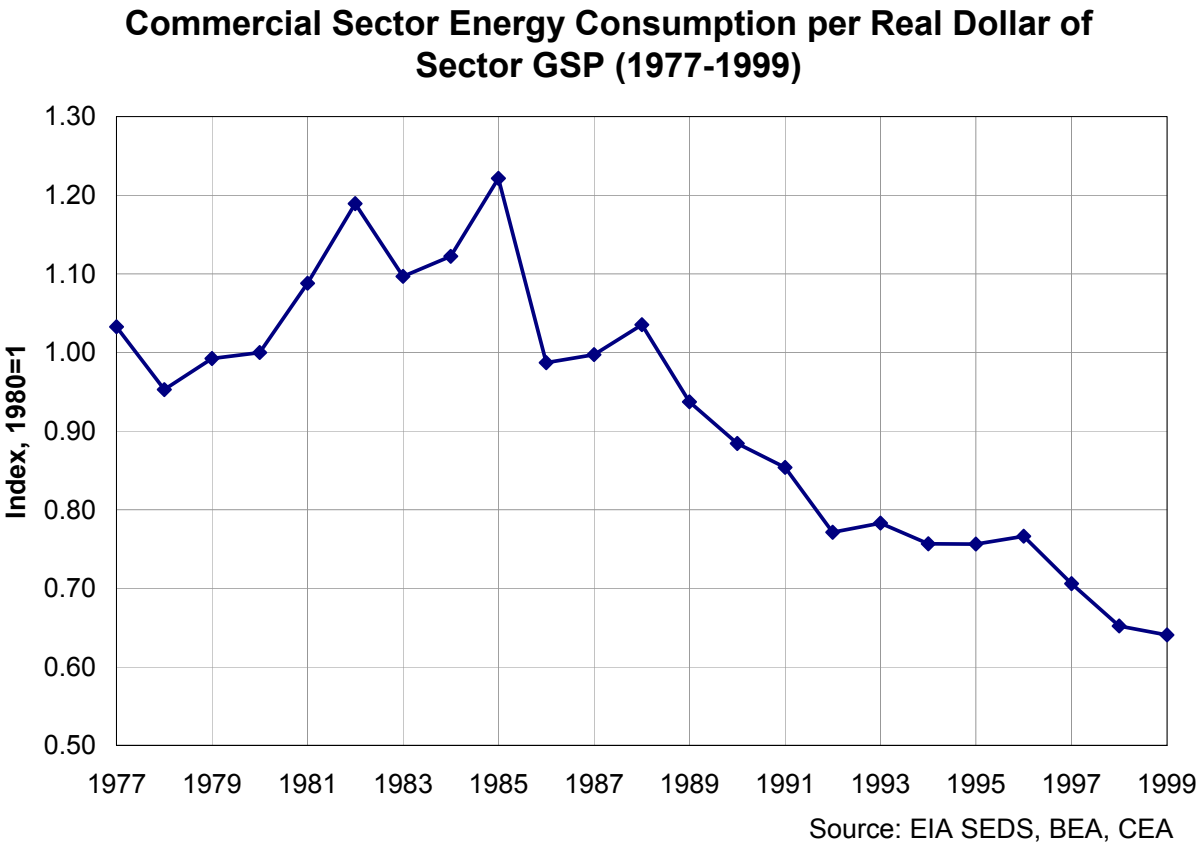
SOURCE: EIA SEDS

ELECTRICITY ACCOUNTS FOR ABOUT 60% OF END-USE ENERGY CONSUMPTION IN THE COMMERCIAL SECTOR. NATURAL GAS MAKES UP THE BULK OF THE REST. SINCE 1990 ELECTRICITY CONSUMPTION HAS BEEN GROWING AT AN AVERAGE RATE OF 2.4% PER YEAR WHILE NATURAL GAS USE HAS BEEN GROWING AT A 3.3% RATE.

Electricity and natural gas are the dominant fuels in Washington's commercial sector. With escalating use of electricity-consuming equipment such as computers, printers, and photocopiers, the commercial sector became increasingly reliant on electricity during the 1970's and 1980's. Sector electricity consumption has quadrupled since 1970.

Natural gas lost market share in the late 1970s and early 1980s, but has mostly recovered since 1985. In contrast, petroleum consumption is less than half of early 1970s levels, declining from 30% of commercial energy consumption in 1970 to 4% in 1999.

13. Commercial Sector Trends — Commercial Sector Energy Intensity

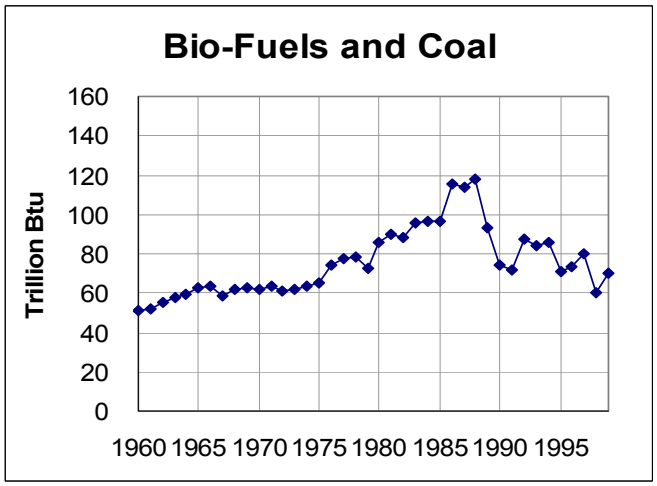


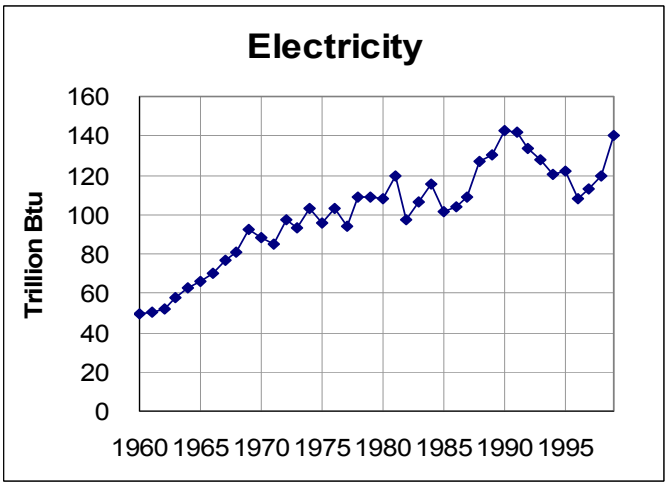
COMMERCIAL SECTOR ENERGY CONSUMPTION HAS DECLINED RAPIDLY RELATIVE TO ECONOMIC OUTPUT SINCE THE MID-1980S.

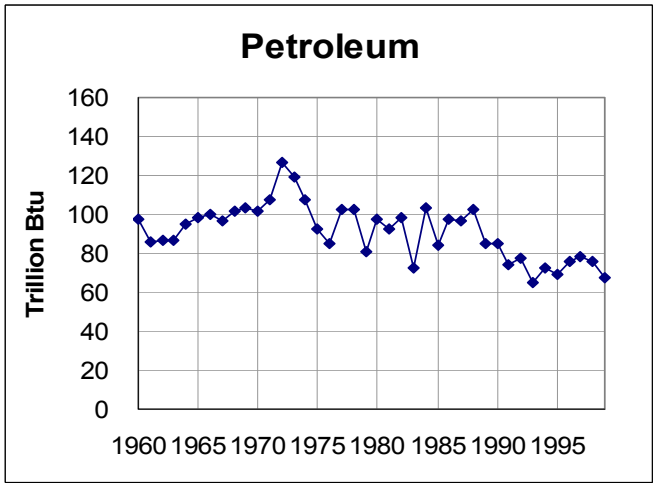
Washington's commercial sector has become much less energy intensive over the last 15 years. Commercial sector energy consumption more than doubled between 1970 and 1985, but since 1985 has grown only 11%. Meanwhile, the value of all goods and services produced by the commercial sector has more than doubled in real terms since 1985. Growth in the economy, shifts to less energy intensive businesses, increased productivity, and improvements in the efficiency of buildings, lighting, and equipment have all played a role in declining commercial sector energy intensity.

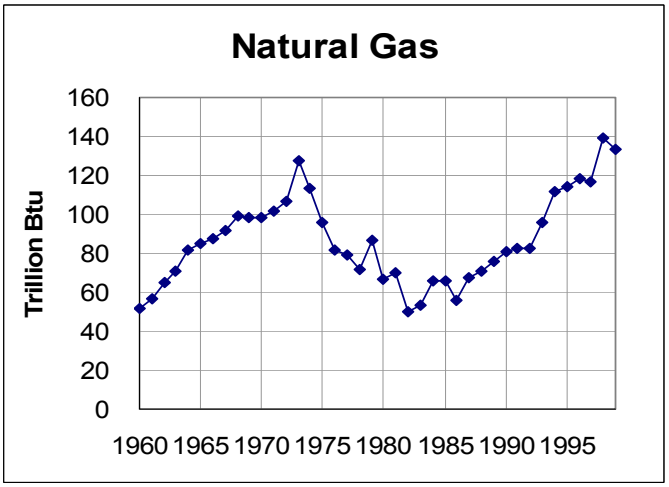
14. Industrial Sector Trends — End-Use Energy Consumption by Fuel

Industrial Energy Consumption by Fuel (1960-1999)









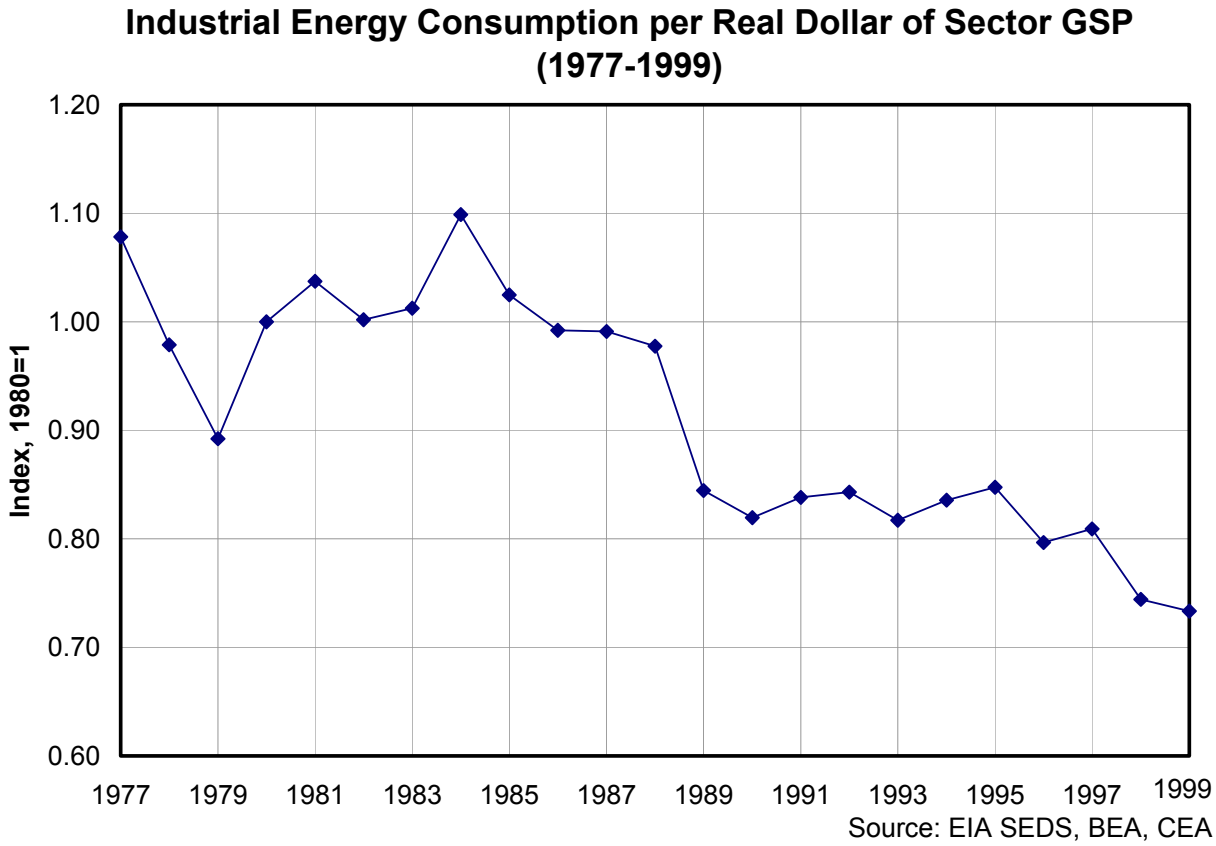
SOURCE: EIA SEDS

INDUSTRIAL ENERGY CONSUMPTION IN WASHINGTON IS SPLIT MORE EVENLY AMONG THE DIFFERENT FUELS THAN THE OTHER SECTORS. AS IN OTHER SECTORS, THE NATURAL GAS SHARE HAS GROWN SINCE THE MID-1980'S.

Unlike the residential and commercial sectors, which rely primarily on electricity and natural gas, or the transportation sector which consumes almost exclusively petroleum fuels, energy consumption in Washington's industrial sector is quite diversified. Electricity and natural gas still account for the largest shares (about a third each), but biofuels, coal, and petroleum account for the remaining third. While the relative market share of electricity has not changed much in the last 10 years or so, the share for petroleum and biofuels declined while the natural gas share increased. Natural gas consumption declined precipitously between 1973 and 1982 (driven by increasing prices), but has grown 23% from 1985 to 1990, and 65% from 1990 to 1999.

Total industrial sector energy use grew modestly during the 1990's at slightly less than 1% per year. Consumption in 1999 is slightly less than the year of highest consumption in 1988. Energy consumption in the industrial sector tends to vary more than the other sectors with peaks and valleys that mirror the economy.

15. Industrial Sector Trends — Industrial Sector Energy Intensity

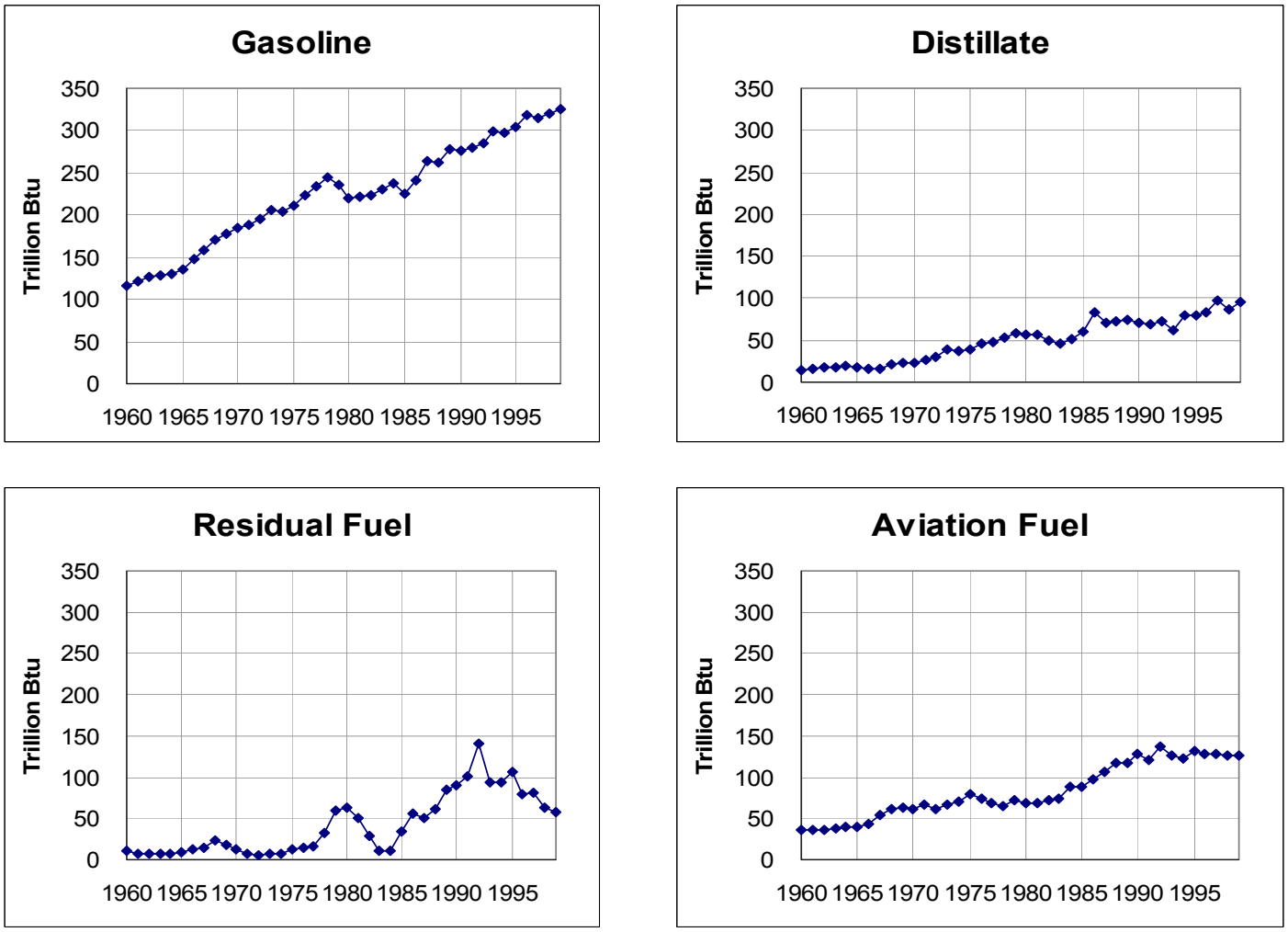


ENERGY INTENSITY IN WASHINGTON'S INDUSTRIAL SECTOR HAS DECLINED OVER THE PAST FIFTEEN YEARS, BUT TENDS TO BE MORE VOLATILE THAN THE OTHER SECTORS.

Washington's industrial sector is less energy-intensive than it was two decades ago, but energy intensity has not consistently declined over this period. Both energy consumption and industrial production can vary from year-to-year depending on the economy and market conditions. Energy consumption in the industrial sector peaked in 1973 and 1988 and is near its all time high in 1999, but in between these years it was down 10% to 15%. Petroleum energy use in particular commonly goes up and down from one year to next. Industrial production contracted 13% between 1979 and 1985, grew by 38% between 1985 and 1990, and stayed relatively constant through 1996, before rising 19% by 1999. Industrial energy intensity reflected these changes in production, declining from 1983 to 1990, remaining relatively constant through 1995, and then declining again.

16. Transportation Sector Trends — End-Use Energy Consumption by Fuel

Transportation Energy Consumption by Fuel (1960-1999)



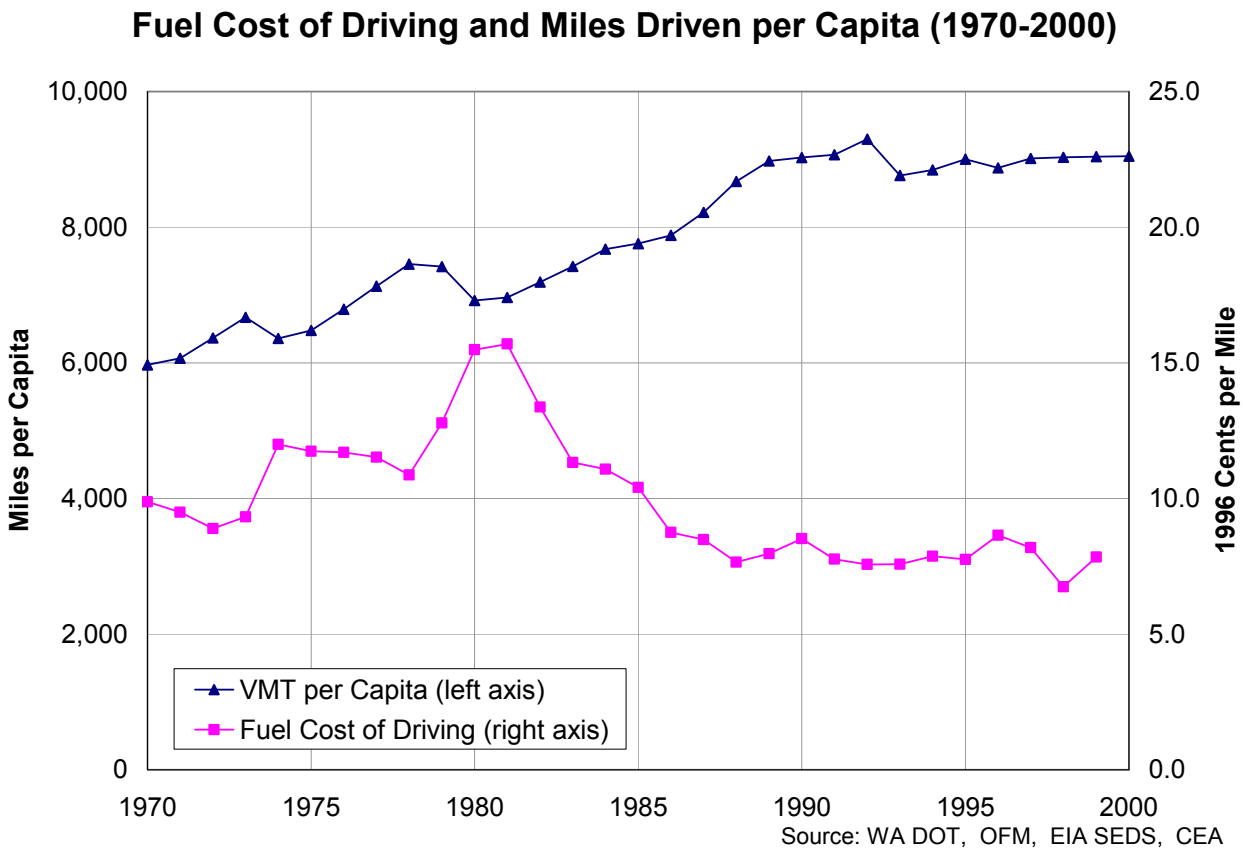
SOURCE: EIA SEDS

GASOLINE ACCOUNTS FOR OVER HALF OF TRANSPORTATION SECTOR ENERGY USE IN WASHINGTON. WHILE WASHINGTONIANS TEND TO DRIVE MORE THAN OTHER AMERICANS, WASHINGTON'S STATUS AS A MAJOR SEAPORT AND AVIATION HUB MEANS HIGHER CONSUMPTION OF AVIATION AND MARINE FUELS AS WELL.

Motor gasoline is the dominant transportation fuel, accounting for more than half of Washington's transportation energy consumption. Except for the period between 1978 and 1986, gasoline consumption has steadily increased as demand for travel has outstripped gains in vehicle fuel efficiency. Consumption of distillate fuels in trucks (as diesel fuel), ships, and railroads has also grown. Residual fuel consumption is subject to price-induced volatility because it can be stored for long periods of time without degrading.

Aviation fuel consumption closely resembles overall transportation trends. Declining aviation fuel prices have contributed to a significant increase in air travel, overwhelming efficiency improvements in the stock of private, commercial, and military planes. Aviation fuel use more than doubled between 1970 and 1999.

17. Transportation Sector Trends — Fuel Cost of Driving and Miles Driven



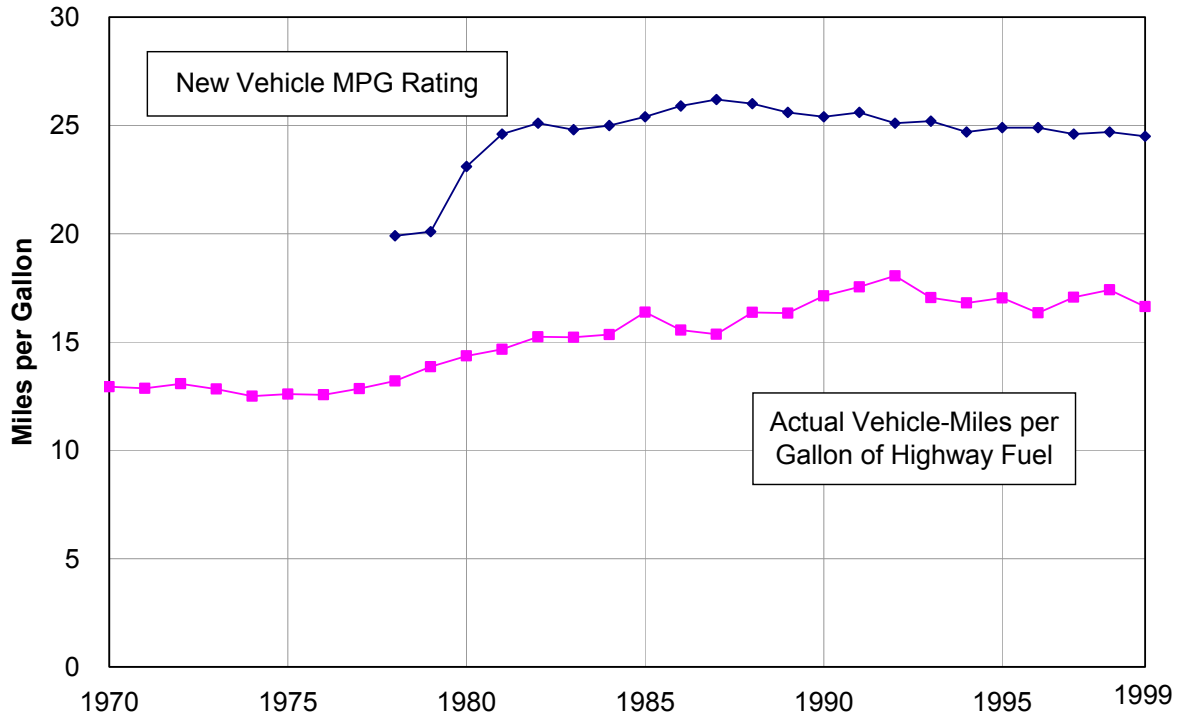
WASHINGTONIANS DROVE 52% MORE MILES PER CAPITA IN 1999 THAN THEY DID IN 1970. DURING THE SAME PERIOD THE FUEL COST OF DRIVING DECLINED 21%, REACHING AN HISTORIC LOW IN 1998.

This indicator juxtaposes the fuel cost of driving with miles driven per capita in Washington. Not surprisingly, these series exhibit a strong inverse relationship. The fuel cost of driving, calculated as real dollar highway energy expenditures divided by vehicle-miles traveled (VMT), spiked upward in 1974 and 1979-1980 as a result of the oil shocks. VMT per capita dropped slightly in response to higher prices, as unnecessary driving was temporarily curtailed. However, long-term factors such as land-use patterns, commuting habits, and the long lifetimes of vehicles mean that large swings in fuel prices lead to only small changes in miles driven.

Increasing sales of more fuel-efficient vehicles in the early 1980s combined with declines in the price of highway fuels caused a rapid drop in the fuel cost of driving, from a high of 15.7¢ per mile in 1981 to 7.6¢ in 1988 (in 1996 dollars). However, real gasoline prices have changed little since 1988, and increases in vehicle fuel efficiency have slowed dramatically as well, resulting in little change in the fuel cost of driving. Low gasoline prices helped push the fuel cost of driving to an historic low in 1998, but higher prices in 1999 reversed this trend. Meanwhile, vehicle travel increased steadily during the 1980's, but has been relatively constant during the 1990's.

18. Transportation Sector Trends — Transportation Sector Energy Intensity

New Vehicle Miles per Gallon and Washington State Actual Vehicle Miles per Gallon (1970-1999)



Sources: EIA, ORNL, WSDOT

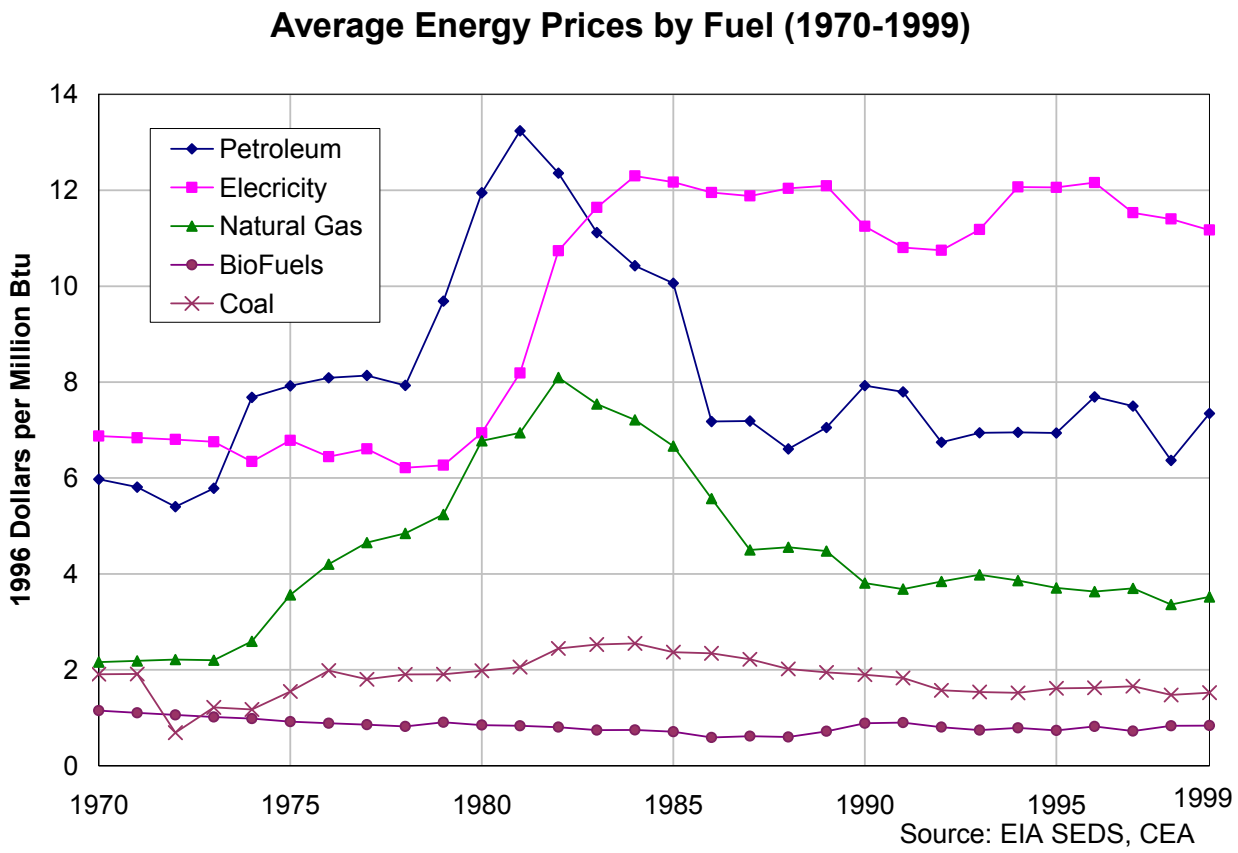
SPURRED BY HIGH GASOLINE PRICES AND IMPROVING NEW VEHICLE FUEL EFFICIENCY, THE FUEL EFFICIENCY OF WASHINGTON'S EXISTING VEHICLE FLEET INCREASED BY MORE THAN 40% BETWEEN 1975 AND 1992. THE INCREASING POPULARITY OF VANS, TRUCKS, AND SPORT UTILITY VEHICLES IN THE 1990S PUT AN END TO THIS TREND.

Like other sectors, Washington's transportation sector has become more energy efficient over the years. The average efficiency of Washington's vehicle fleet grew from 12.6 MPG in 1975 to 18.0 MPG in 1992. However, over fifteen years of improvements in vehicle fuel efficiency appear to have come to an end in the 1990s. Since 1992 Washington's vehicle fleet efficiency declined by almost one and a half miles per gallon.

New vehicle fuel efficiency has not improved since the mid-1980s, when Congress last increased Corporate Average Fuel Economy (CAFE) standards. CAFE standards require automakers to maintain the average fuel efficiency of new vehicles at 27.5 MPG for cars and 20.5 MPG for light trucks (which includes minivans, pickups, and sport-utility vehicles). However, CAFE has no mandates about how many vehicles may be sold in each category, and the increasing popularity of light trucks has caused the fuel efficiency of the average new vehicle to drop by almost two miles per gallon since 1987.

It is important to note that the actual on-road fuel efficiency of new vehicles is less than the EPA-rated fuel efficiency shown in the figure. EIA estimates actual on-road MPG to be 25.5% worse for cars and 18.7% worse for light trucks. The result is that, unlike in other sectors where newer equipment tends to be more energy efficient, this is not the case for new cars and trucks. Thus vehicle stock turnover has not appreciably raised the efficiency of the vehicle fleet since the early 1990s.

19. Energy Price Trends — Average Energy Prices by Fuel

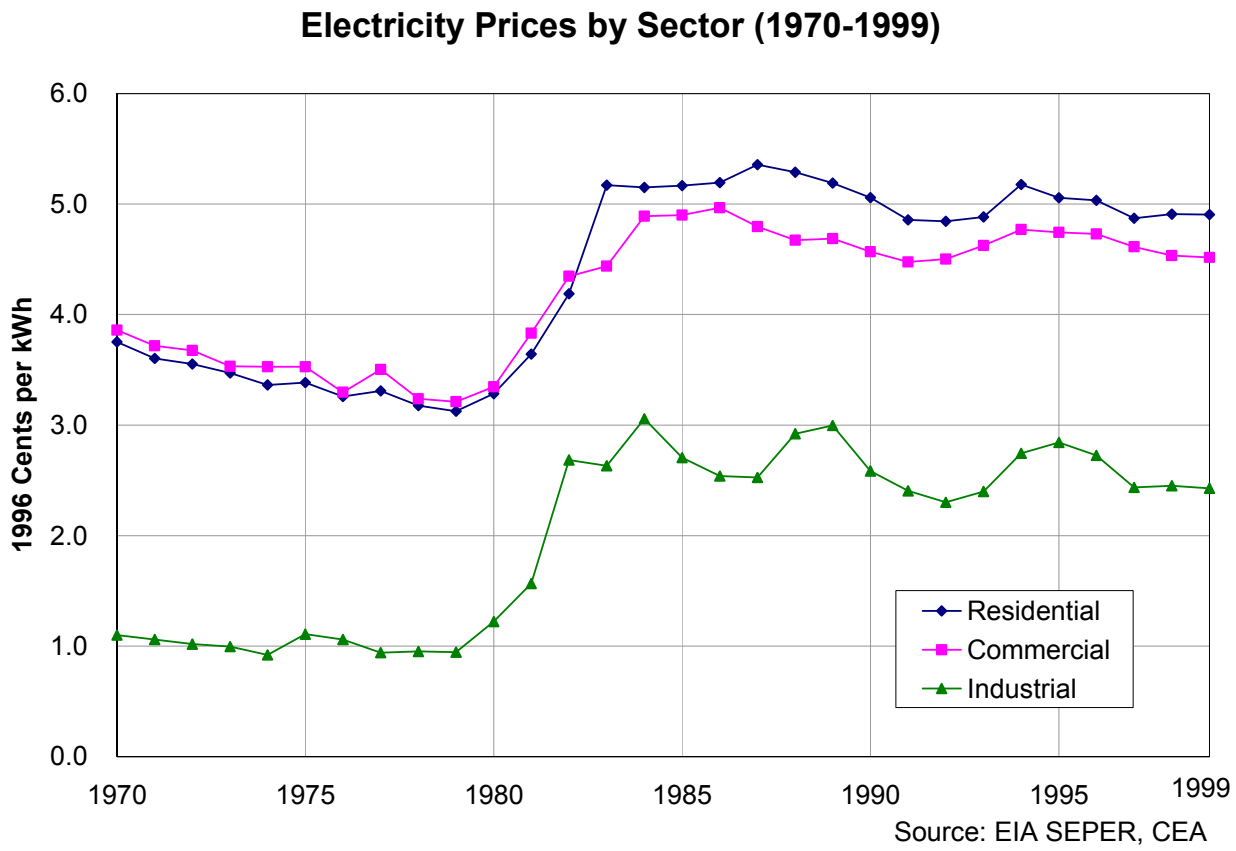


EVEN THOUGH ELECTRICITY PRICES IN WASHINGTON TEND TO BE LOWER THAN IN OTHER PARTS OF THE COUNTRY, ELECTRICITY IS STILL THE MOST EXPENSIVE ENERGY SOURCE. REAL FOSSIL FUEL PRICES HAVE DECLINED SIGNIFICANTLY SINCE THE EARLY 1980'S, BUT AVERAGE ELECTRICITY PRICES HAVE REMAINED RELATIVELY CONSTANT.

While the effect of the oil shocks of 1973 and 1978 on Washington energy prices was dramatic, it was relatively short-lived. Petroleum prices more than doubled from 1972 to 1983 and then quickly settled back to values close to pre-1973 levels. Real natural gas prices followed a similar trend, rising steeply during the 1970s, falling during the 1980s, and staying relatively stable in the 1990s. The average price of electricity, which had been low and stable for years, almost doubled between 1978 and 1984 as the costs of new, large power plants, some of which were never completed, were incorporated into electric utility rates. In contrast to oil prices, real electricity prices have not declined from the level they reached during the early 1980s.

The price increases for all fuels in the 1970s and early 1980s caused real Washington energy expenditures to more than double. Expenditures were 20% lower by 1986 as the price of fossil fuels plummeted, but have since climbed back near the levels of the early 1980s, as energy consumption has increased.

20. Energy Price Trends — Average Electricity Prices by Sector

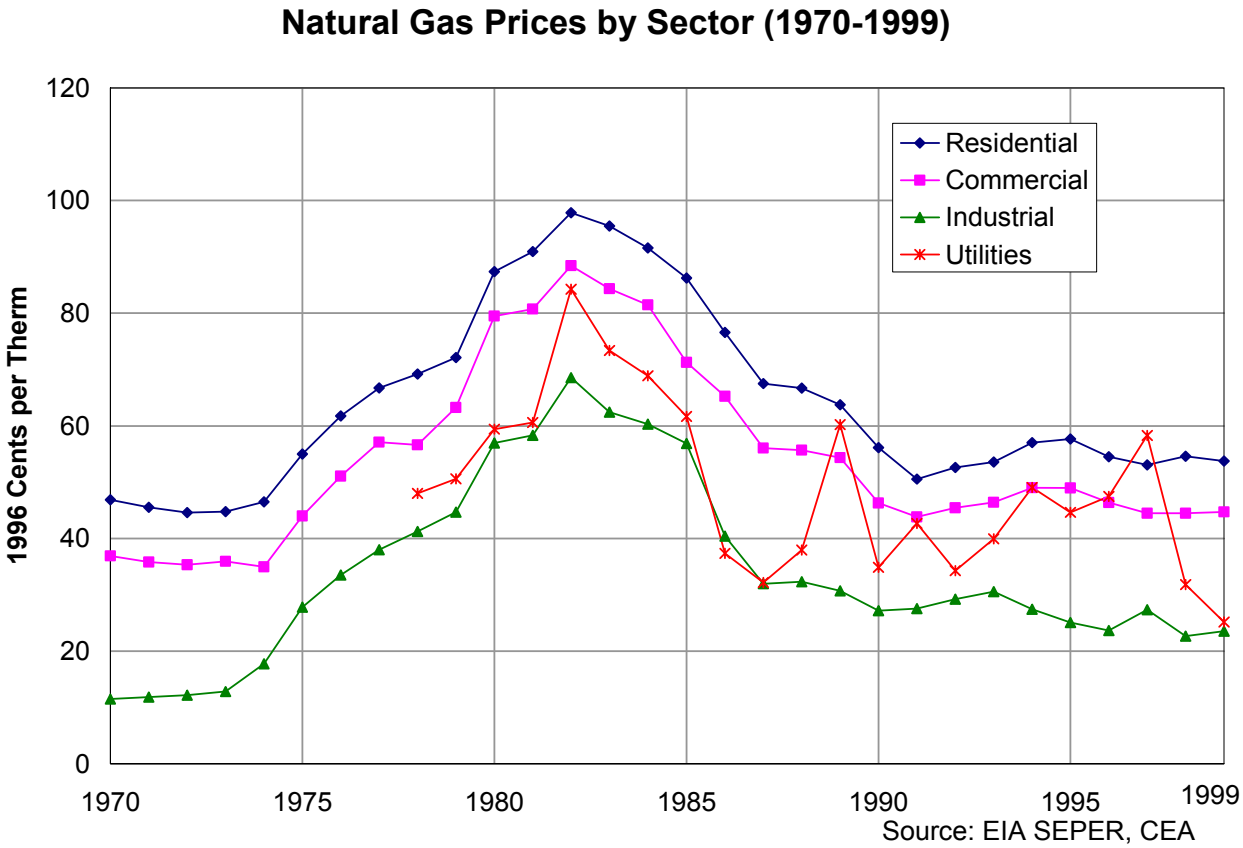


REAL ELECTRICITY PRICES INCREASED DRAMATICALLY BETWEEN 1979 AND 1984, BUT HAVE STAYED RELATIVELY CONSTANT THROUGH 1999. THE MAGNITUDE OF THE INCREASE, PRIMARILY DUE TO DEBT FROM NUCLEAR POWER PLANTS, WAS SIMILAR FOR ALL SECTORS, BUT THE RELATIVE INCREASE WAS MUCH HIGHER FOR THE INDUSTRIAL SECTOR.

The most notable phases in electricity prices are the long, slow decline of prices in the 1970s, the rapid increase between 1979 and 1984, and the period since 1984 when there has been some small up and down variation, but prices have stayed relatively constant. Price trends for the residential and commercial sectors are nearly identical. Industrial sector prices have been more volatile than residential and commercial prices, increasing over 200% between 1979 and 1984, versus 50-65% for the residential and commercial sectors. On a per unit basis, however, the increases were similar for all sectors: 2.0¢ per kWh for residential, 1.7¢ per kWh for commercial, and 2.1¢ per kWh for industrial.

In 2001 and 2002 electricity prices increased as a result of the 2001 energy crisis on the West Coast. This more current information is illustrated (using preliminary estimates for 2001 and 2002) in Section 4 (#5) of Washington's Energy Strategy Update and 2003 Biennial Energy Report (http://www.energy.cted.wa.gov/Energy%20Strategy/Default.htm

21. Energy Price Trends — Average Natural Gas Prices by Sector



NATURAL GAS PRICES INCREASED RAPIDLY FOR ALL SECTORS BETWEEN 1974 AND 1982 AND DECLINED JUST AS RAPIDLY FROM 1982 TO 1991. INDUSTRIAL SECTOR GAS PRICES HAVE CONTINUED TO DECLINE SINCE THEN, WHILE RESIDENTIAL AND COMMERCIAL RATES HAVE SEEN MODEST INCREASES. PRICES FOR UTILITIES WERE RELATIVELY VOLATILE DURING THIS PERIOD DUE TO MODEST CONSUMPTION.

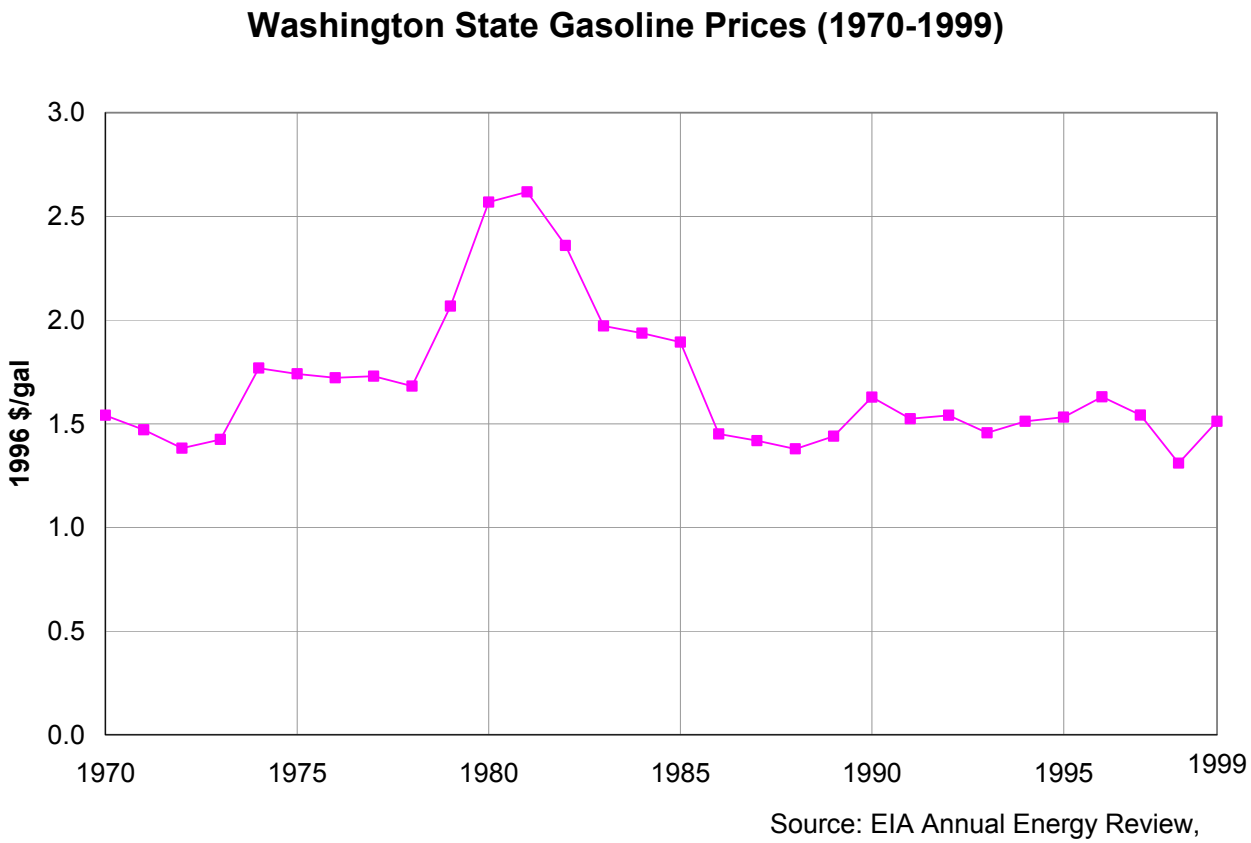
Real natural gas prices were stable in the early 1970s, increased rapidly between 1974 and 1982, and declined just as rapidly between 1982 and 1991. As with electricity, the price increases during the 1970s were of similar magnitude in all sectors on a per unit basis, but were much larger in percentage terms for the industrial sector.

Price trends have diverged in the 1990s. Residential and commercial customers experienced price increases of 6% and 2%, respectively, between 1991 and 1999. Average industrial sector natural gas prices declined by 14.5% over the same period. Many large industrial customers have begun to make bulk purchases of commodity gas from suppliers other than their local utilities.

Natural gas in the utility sector has historically been used to fire relatively small power plants used for "peaking", which at least partially explains the volatility experienced in that sector. With a number of gas-fired plants recently constructed or in the planning stages, utility sector consumption of natural gas will soon become more significant.

Beginning in 2000 natural gas prices began to rise due to constrained natural gas capacity and increased demand. More current information on natural gas prices is shown (using preliminary estimates for 2000 and 2001) in Section 4 (#5) of Washington's Energy Strategy Update and 2003 Biennial Energy Report. (http://www.energy.cted.wa.gov/Energy%20Strategy/Default.htm).

22. Energy Price Trends — Washington Gasoline Prices Since 1970



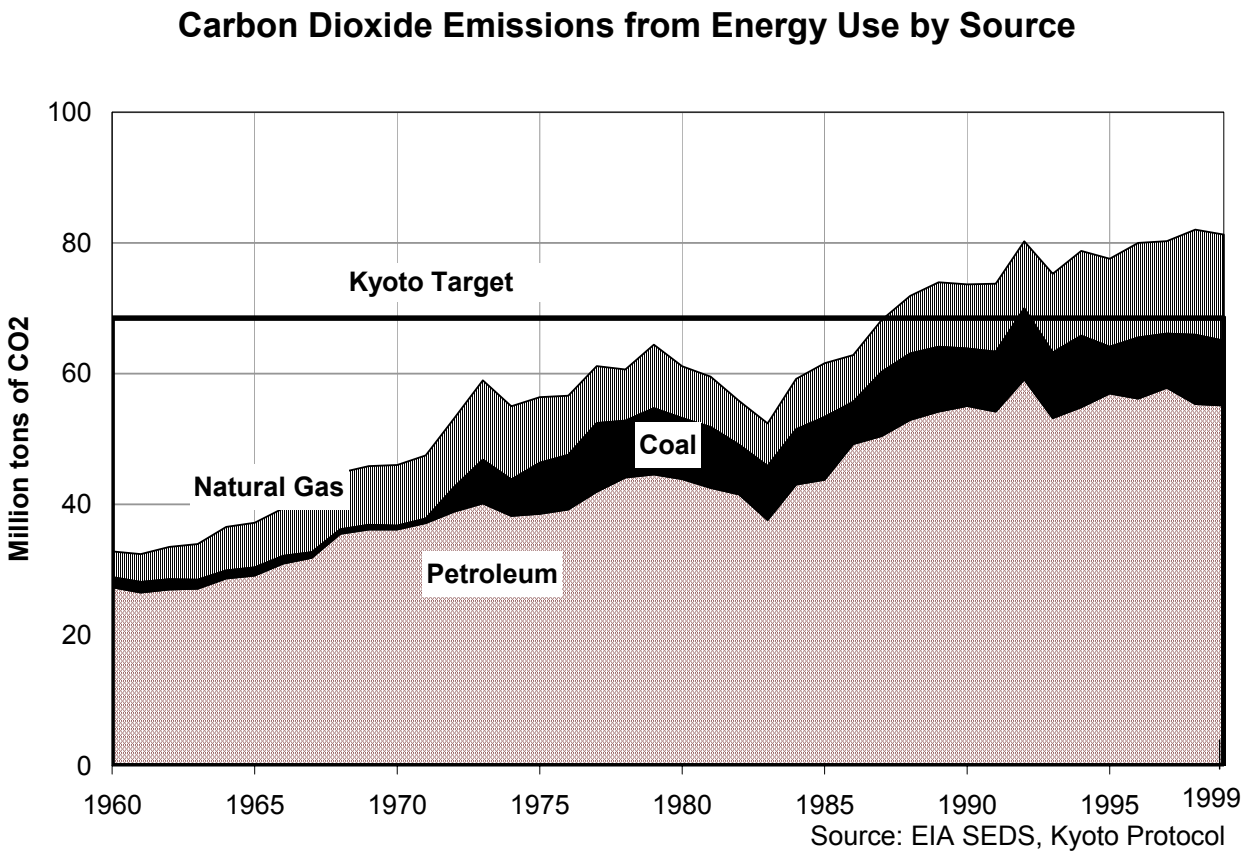
Source: EIA Annual Energy Review,

ADJUSTED FOR INFLATION, GASOLINE PRICES IN WASHINGTON IN 1999 ARE SIMILAR TO PRICES IN 1970 PRIOR TO THE OIL CRISIS. THESE PRICES ARE MUCH LESS THAN THE PRICES RESULTING FROM THE OIL CRISIS IN THE EARLY 1980S.

After peaking at more than $2.50 per gallon (1996 dollars), inflation-adjusted gasoline prices returned to pre-oil crisis levels by the mid-1990s. In 1998, gasoline prices fell to their lowest level in this 20-year period, but rose again in 1999, reflecting world oil prices.

The dominant trend in gasoline prices in Washington has been relative stability with the exception of the 1973-1985 period of OPEC unity. The majority of petroleum for Washington comes from Alaska and most of this petroleum is refined into gasoline in Washington, but the price we pay for gasoline is influenced by world oil prices. Adjusted for inflation to 1996 dollars, a gallon of gasoline cost $1.54 in 1970, $2.57 in 1980, $1.63 in 1990, and $1.51 in 1999. Gasoline prices in Washington tend to be a little bit higher than the national average.

23. Environmental Trends — Energy-Related Greenhouse Gas Emissions



WASHINGTON'S INCREASING RELIANCE ON FOSSIL FUELS HAS LED TO STEADY GROWTH IN EMISSIONS OF CARBON DIOXIDE, THE PRINCIPAL GREENHOUSE GAS. PETROLEUM USE, PRIMARILY FOR TRANSPORTATION, ACCOUNTS FOR 72% OF CO_2 EMISSIONS FROM ENERGY USE IN WASHINGTON.

Washington's continued dependence on fossil fuels for energy, particularly petroleum, has led to rapid growth in emissions of carbon dioxide (CO_2), the principal "greenhouse gas" contributing to global climate change. After dipping in the early 1980s, growth in carbon dioxide emissions accelerated after 1983 as the economy recovered from the recession and oil prices plummeted. Washington's CO_2 emissions from energy use grew by 2.6% per year between 1985 and 1999.

Consumption of petroleum products, the vast majority for transportation, accounts for almost 70 percent of Washington's CO_2 emissions.

Emissions from coal are almost entirely from one source, the Centralia Steam Plant which burns coal to produce electricity. Natural gas contains less carbon per unit of energy than other fossil fuels, but because of higher levels of consumption accounts for a larger share of Washington's CO_2 emissions than coal.

Also depicted is the emission target agreed to during the Kyoto negotiations in 1997, which is 7% below 1990 levels. Meeting this target would require a 16% reduction from Washington's 1999 emissions level.

Energy Indicators Sources and Data Notes

1 Washington's Energy Use — End-Use Energy Consumption By Sector

Source: Energy Information Administration's State Energy Data System

2 Washington's Energy Use — Primary Energy Consumption by Source

Source: Energy Information Administration's State Energy Data System

EIA uses each state's mix of electric generation to map electricity consumption to production by primary fuels. This overstates the contribution of hydroelectricity, as Washington is part of an interconnected regional electric grid and relies on generation sources in other states that are less hydroelectric-intensive. (See Indicator #3).

The difference between primary and end-use energy consumption is the treatment of electricity (other fuels such as natural gas, petroleum, and coal are primary energy sources). Electricity must be generated using energy sources such as coal, natural gas, or falling water. These inputs to the power plant are counted as primary energy; the output of the power plant that is sold to homes and businesses is end-use electricity. Since over half of the energy inputs to thermal power plants are typically lost as waste heat, primary energy is larger than end-use.

3 Washington's Energy Use — Electricity Generation and Consumption by Source

Source: Washington State Fuel Mix Disclosure Database, Energy Policy Group, Washington State Office of Trade and Economic Development

4 Washington's Energy Bill — End Use Energy Expenditures

Sources: Energy Information Administration's State Energy Price and Expenditure Report; President's Council of Economic Advisors

5 Washington's Energy Intensity — Energy Consumption per Dollar of Gross State Product

Sources: Energy Information Administration's State Energy Data System; U.S. Department of Commerce, Bureau of Economic Analysis; President's Council of Economic Advisors

6 Washington's Energy Intensity — Energy Consumption per Capita

Sources: Energy Information Administration's State Energy Data System; Washington State Office of Financial Management

7 Washington's Energy Intensity — Energy Expenditures per Dollar of Washington GSP

Sources: Energy Information Administration's State Energy Price and Expenditure Report; U.S. Department of Commerce, Bureau of Economic Analysis; President's Council of Economic Advisors;

Energy expenditures include expenditures by households and businesses, and for personal and business transportation.

8 Residential Sector Trends — End-Use Energy Consumption by Fuel

Source: Energy Information Administration's State Energy Data System

The primary petroleum products consumed in households are heating oil (No. 2 distillate oil) and propane. Both are consumed mainly for space heating, though propane can also be used for cooking and water heating. Residential sector energy use does not include energy consumption for personal transportation.

9 Residential Sector Trends — Household Energy Intensity

Sources: Energy Information Administration's State Energy Data System; U.S. Department of Commerce, Bureau of the Census

10 Residential Sector Trends — Household Energy Bill

Sources: Energy Information Administration's State Energy Price and Expenditure Report; U.S. Department of Commerce, Bureau of the Census; and Bureau of Economic Analysis; President's Council of Economic Advisors

11 Residential Sector Trends — Household Energy Bill with Transportation

Source: Energy Information Administration's State Energy Data System and the Residential Energy Consumption Survey; U.S. Department of Transportation, Federal Highway Administration Highway Statistics

These figures apportion the household energy bill to end-use shares using information from the 1997 Residential Energy Consumption Survey. Household transportation energy expenditures are estimated based on an estimate of the portion of motor gasoline expenditures that are made by households.

12 Commercial Sector Trends — End-Use Energy Consumption by Fuel

Source: Energy Information Administration's State Energy Data System

13 Commercial Sector Trends — Sector Energy Intensity

Sources: Energy Information Administration's State Energy Data System; U.S. Department of Commerce, Bureau of Economic Analysis; President's Council of Economic Advisors

14 Industrial Sector Trends — Energy Consumption by Fuel

Source: Energy Information Administration's State Energy Data System

Bio-fuels consumed in the industrial sector comprise mainly wood and wood waste products such as black liquor or hog fuel. These fuels are primarily burned in industrial boilers to make steam, which can be used to fire industrial processes or to generate electricity for on-site use. Industrial coal consumption has declined from a high of 14 trillion Btus in 1976 to 2.2 trillion Btus in 1999.

15 Industrial Sector Trends — Industrial Sector Energy Intensity

Sources: Energy Information Administration's State Energy Data System; U.S. Department of Commerce, Bureau of Economic Analysis; President's Council of Economic Advisors

Note that electricity consumption for the industrial sector includes consumption for the direct service industries (DSIs) that purchase electricity directly from the Bonneville Power Administration.

16 Transportation Sector Trends — End-Use Energy Consumption by Fuel

Source: Energy Information Administration's State Energy Data System

Motor gasoline figures include some consumption for off-road uses such as recreational vehicles and agricultural uses. No. 2 distillate, also known as diesel fuel, is used by large trucks, ships, and railroads. The only transportation use for residual fuel is by very large ships. Aviation fuel includes kerosene-based jet fuel used by major airlines, aviation gasoline consumed by smaller airplanes, and military jet fuel.

17 Transportation Sector Trends — Fuel Cost of Driving and Miles Driven per Capita

Sources: Energy Information Administration's State Energy Data System; President's Council of Economic Advisors; U.S. Department of Transportation, Federal Highway Administration, Washington State Dept. of Transportation, Washington State Office of Financial Management.

18 Transportation Sector Trends — Transportation Sector Energy Intensity

Sources: Energy Information Administration's State Energy Data System; Washington State Dept. of Transportation; US Dept of Energy Center for Transportation Analysis at the Oak Ridge National Laboratories

Note that on-raid fuel efficiency is less than the official, EPA-rated fuel efficiency for new cars. The Energy Information Administration estimates actual, on-road performance to be 25.5% worse than the EPA rating for cars and 18.7% worse for light trucks for new cars in 2000 (EIA, *National Energy Modeling System*, Fuel Economy Degradation Factor).

19 Energy Price Trends - Average Energy Prices by Fuel

Sources: Energy Information Administration's State Energy Data System; President's Council of Economic Advisors

20 Energy Price Trends - Average Electricity Prices by Sector

Sources: Energy Information Administration's State Energy Price and Expenditure Report; President's Council of Economic Advisors

21 Energy Price Trends - Average Natural Gas Prices by Sector

Sources: Energy Information Administration's State Energy Price and Expenditure Report; President's Council of Economic Advisors

22 **Energy** Price Trends - Washington Gasoline Prices Since 1970

Sources: Energy Information Administration's Annual Energy Review; President's Council of Economic Advisors

23 Environmental Trends - Energy-Related Greenhouse Gas Emissions

Sources: Energy Information Administration's State Energy Data System, Kyoto Protocol

Energy Indicators Methodology

Introduction

Most publicly available comprehensive energy data at the state level originate with surveys and estimates developed by the Energy Information Administration (EIA), an independent branch of the federal Department of Energy. We rely heavily on the EIA's State Energy Data System (SEDS) to produce Energy Indicators and other products. However we modify data from the EIA, based on years of experience with their components and their fit with the needs of the Energy Indicators. This includes the exclusion of non-energy uses of petroleum and how we calculate the primary energy value for hydroelectricity generation.

Excluded Petroleum Products

We exclude the consumption of petroleum products for non-energy purposes. This includes asphalt, road oil, and lubricants from the transportation and industrial sectors. These are easily removed series that are clearly not used as energy sources.

We also exclude industrial petroleum coke, used in various forms as a source of pure carbon. The EIA series for industrial coke comprises coke used in oil refining and primary aluminum smelting. Neither of these processes uses coke for its energy content, but rather for its catalytic and conductive properties. These two types of coke are allocated to states, not according to measured use at the state level, but instead based on their share of the United States' annual capacity in the respective industries multiplied against US industrial coke use. The capacity of both these industries has grown considerably in Washington, and their share of the US total has also grown.

Indexed against 1970, the first year in which data pairs showing consumption and expenditure are available in SEDS, the Washington aluminum loss rate for fossil fuel powered generation, in an effort to enable comparison of primary energy consumption between individual states. We remove those imputed losses from our primary totals. This difference does not affect depictions of industry expanded by almost a third by 1997, and represented the largest primary smelting share of any state, at 29% of the nation's total.

While representing a much smaller share of the nation's petroleum refining industry, Washington's oil refineries have seen continued growth throughout the span of the data in these Indicators, while US capacity has changed little since the mid-80s.

The effect of these growing industries combined with the EIA inclusion of the (non-energy) petroleum coke they use as industrial energy consumption has resulted in distortion of the true patterns of industrial energy consumption, and thus an inflated view of energy use overall in Washington. That effect is magnified in the past two decades, when at their peak, these non-fuel petroleum products accounted for more than 1/4th of the total Washington industrial energy use claimed by the EIA.

We have also excluded other uses such as petroleum used as feedstock for paints and solvents, or to make waxes to coat packaging. The focus of this analysis is energy consumption in Washington, rather than the supply of and demand for petroleum products or other fossil fuels. Excluding these non-energy uses provides the most accurate picture of the consumption of energy in the state.

Hydroelectric Conversion

One last methodological note must be made to explain the differences one may notice here compared to other tallies of state energy use. In a steam powered generator, as much as two-thirds of the heat in the fuel burned to produce electricity is lost. Hydroelectric power generation does not experience thermal losses, but the EIA assigns losses to it equivalent to an average

sector end-use consumption of energy, as these do not show primary consumption.

Methodology Summary

In summary, large amounts of non-energy petroleum products used in aluminum smelting and oil refining, and the large role hydroelectricity plays in the state's energy supply require modifications to standard views of energy consumption to portray accurately the trends depicted in these Indicators.